MOD

The Future of Food

Designing for the Human Microbiome

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Abbye Churchill is an artist, curator and writer. Her writing has appeared in *The New York Times*, *Vogue*, *Food + Wine*, *Condé Nast Traveller* and *W*, among others. Her first book, *A Wilder Life*, co-written with Celestine Maddy, was featured in the *New York Times* "Best of Summer Round-Up." She currently lives in Chicago, where she co-directs the artist-run gallery space Public Access and runs the artist's bookstore Gazebo Projects.

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Alexandra Daisy Ginsberg develops experimental approaches to imagine alternative values around design, science and technology. Lead author of *Synthetic Aesthetics: Investigating Synthetic Biology's Designs on Nature*, her Ph.D. research, *Better*, at London's Royal College of Art, looks into the powerful social imaginary of "better" and its influence on our lives. Daisy received the London Design Medal for Emerging Talent 2012, and her work has been twice nominated for Designs of The Year.

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Anissa Helou is a chef, food writer, journalist, broadcaster and consultant focusing on the cuisines and culinary heritage of the Middle East, Mediterranean and North Africa. Anissa is the author of numerous award-winning cookbooks including *Levant*, *Lebanese Cuisine* and *Sweet Middle East*. She has recently moved from London to Sicily where she will build her dream house with a teaching kitchen and an edible garden over-looking the Mediterranean.

CENTER FOR GENOMIC GASTRONOMY

The Center for Genomic Gastronomy is an artist-led think tank that examines the biotechnologies and biodiversity of human food systems. The Center's mission is to map food controversies, prototype alternative culinary futures, and imagine a more just, biodiverse and beautiful food system. Founded in 2010 by Zack Denfeld and Cathrine Kramer, the Center presents its research through public lectures, research publications, meals and exhibitions.

DANIELLE LEE

Danielle (Dani) Lee, MPH, RD is a San Francisco Bay Area-based public health nutritionist working to improve Americans' access to nutritious and sustainable food. With over seven years experience collaborating to create and manage sustainable foodservice projects good food policies, Dani believes in the power of community to create healthier food environments.

DAVID BRANDON GEETING

David Brandon Geeting brings light to things that are otherwise insignificant, straddling between the worlds of fashion and portraiture. His still life photography gives new meaning to objects as they are re-assembled and juxtaposed together in colorful, unexpected and humorous combinations. He lives and works in New York City.

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Isabelle Legeron, MW is France's only female Master of Wine and the winner of the Madame Bollinger award for Excellence in Tasting, the Villa Maria award for Viticulture and the 'Wine Woman of the Year' award in Paris. She created RAW WINE, the UK's largest artisan wine fair, which now includes an annual event in Berlin and New York. Isabelle contributes to *Decanter* magazine and her first book, *Natural Wine*, was shortlisted for the Fortnum & Mason Best Drinks Book, the Louis Roederer and André Simon awards.

JAMER HUNT

Jamer Hunt collaboratively designs open and flexible programs for participation that respond to emergent cultural conditions. He is the Vice Provost for Transdisciplinary Initiatives at The New School, where he was founding director of the graduate program in Transdisciplinary Design at Parsons School of Design. With Paola Antonelli at the MoMA he was co-creator of the award-winning, curatorial experiment and book *Design and Violence*, as well as collaborating on the *HeadSpace: On Scent as Design* and *The Design and the Elastic Mind* symposia.

JON SANTOS

Jon Santos is a multi-disciplinary artist working in video, sound, performance and sculpture. He is the principal of Common Space, a New York City-bsed multi-disciplinary design studio. Notable projects include

JON SANTOS (*continued*)

For Freedoms, Ontopo and *Hearsay of the Soul* designed for Werner Herzog's Whitney Biennial installation. He is an adjunct professor at Pratt Institute and former visiting artist at Saint-Lukas Academy in Brussels, adjunct professor at the California College of Arts in San Francisco, and guest lecturer at the American Institute of Graphic Arts.

KWANG UH

Kwang Uh is co-founder and chef of Baroo, a free-style experimental kitchen that serves seasonal, local and inspired food in Los Angeles. The restaurant critic Jonathan Gold described Baroo as "a taste of the future" in his LA Times review, and the restaurant has made the best new restaurant lists of *Bon Appétit*, *GQ*, *LA Weekly*, *Vogue*, *Thrillist* and *Eater* amongst others, as well as a semi-finalist nomination for the James Beard Foundation Award.

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Marije Vogelzang is an eating-designer based in The Netherlands and the head of the FOOD NON FOOD department at Design Academy Eindhoven. Her studio practice includes projects ranging from restaurant concepts, medical design and consulting for the food industry. Marije was named one of *Fast Company*'s 100 Most Creative People in Business, was a finalist of the World Technology awards, and profiled on the GOOD100 list. She is also an ambassador of Dutch Cuisine.

OKOLO

OKOLO is a creative group based in Prague with a focus on the fields of design, architecture, art, style, fashion and the entire scope of cultural city life. Through activities including journalism, curatorial exhibitions, special projects and events—OKOLO attempts to find new ways of expressing fine art creativity.

PETER McCOY

Peter McCoy is the co-founder of Radical Mycology, a grassroots organization and movement that educates around mush-rooms and other fungi for personal, societal and ecological resilience. Peter's work is guided by his vision of a more myco-literate culture where the existing knowledge gap around the Fungal Kingdom is closed and the many gifts of these incredible organisms have been fully embraced.

MOLD

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EDITOR'S NOTE

While scrolling through news feeds and flicking through magazines, the featured dishes, diets and ingredients beckon for us to indulge. From the perfectly symmetrical to the casually off-kilter, the ooey gooey to the crackling and crispy, food media serves up aspirational, highly-stylized images designed to stimulate hunger and envy. But probe the global food system that underpins these images, and a less appetizing picture emerges. Although food choice in the developed world is more plentiful than ever, the production and distribution of food globally has become warped: waste is rife yet malnutrition is rampant, and climate change and industrial agricultural practices threaten the future of everything from seafood to citrus. The content feeds of food media will not feed a growing global population. Instead, these stories market food as the ultimate in experiential luxury in a time when food security is uncertain.

With the challenge of feeding 9 billion people by the year 2050, MOLD Magazine moves beyond the aesthetics of food—each issue celebrates design as an agent of change in our food system. MOLD explores the innovations emerging at the intersections of science, technology, agronomy, gastronomy, engineering and design that could define a new era of food and address the systemic problems of how we produce, distribute and consume food. MOLD is for those who love food and culture, not foodie culture.

This debut issue embraces our most ancient collaborator—microbes—and honors their integral role in producing many of our most revered foods and maintaining human health. These (mostly) single-celled organisms are the foundation of life on this planet. They inhabit everything—our bodies and insides teem with trillions of them and with each bite of food we ingest tens of thousands more. It's a strange thing to discover that "me" is actually "we," but advances in science and technology have allowed us to better understand that microbes are foundational in the complex ecosystem of the human body and account for more than 50% of the cells inside each and every one of us. The heart of the human-microbe story is a mutualistic relationship where humans create (or serve as) environments for these tiny living factories to thrive, and in turn, access key chemicals and nutrients industriously produced by them. Issue 01, *Designing for the Human Microbiome*, takes a closer look at harnessing the power of microbes—in ancient fermentation techniques made modern, designing technologies around the biofeed-back loop of poop, and the possibilities (and dangers) of organism design in synthetic biology. Microbes will be co-creators of a more resilient and adaptable food system, offering a blueprint for building a sustainable "we."

Issue 02, *A Place at the Table*, which will explore experimental utensils, eating in virtual reality, dining furniture and the ways that tableware might shape future rituals around food, is already in process. Issue 03, *Waste Not Want Not* will highlight the myriadopportunities for reducing our energy footprint by cutting down food waste and reimagining food packaging. In this context, design can create solutions that are regenerative, functional, desirable and mutualistic.

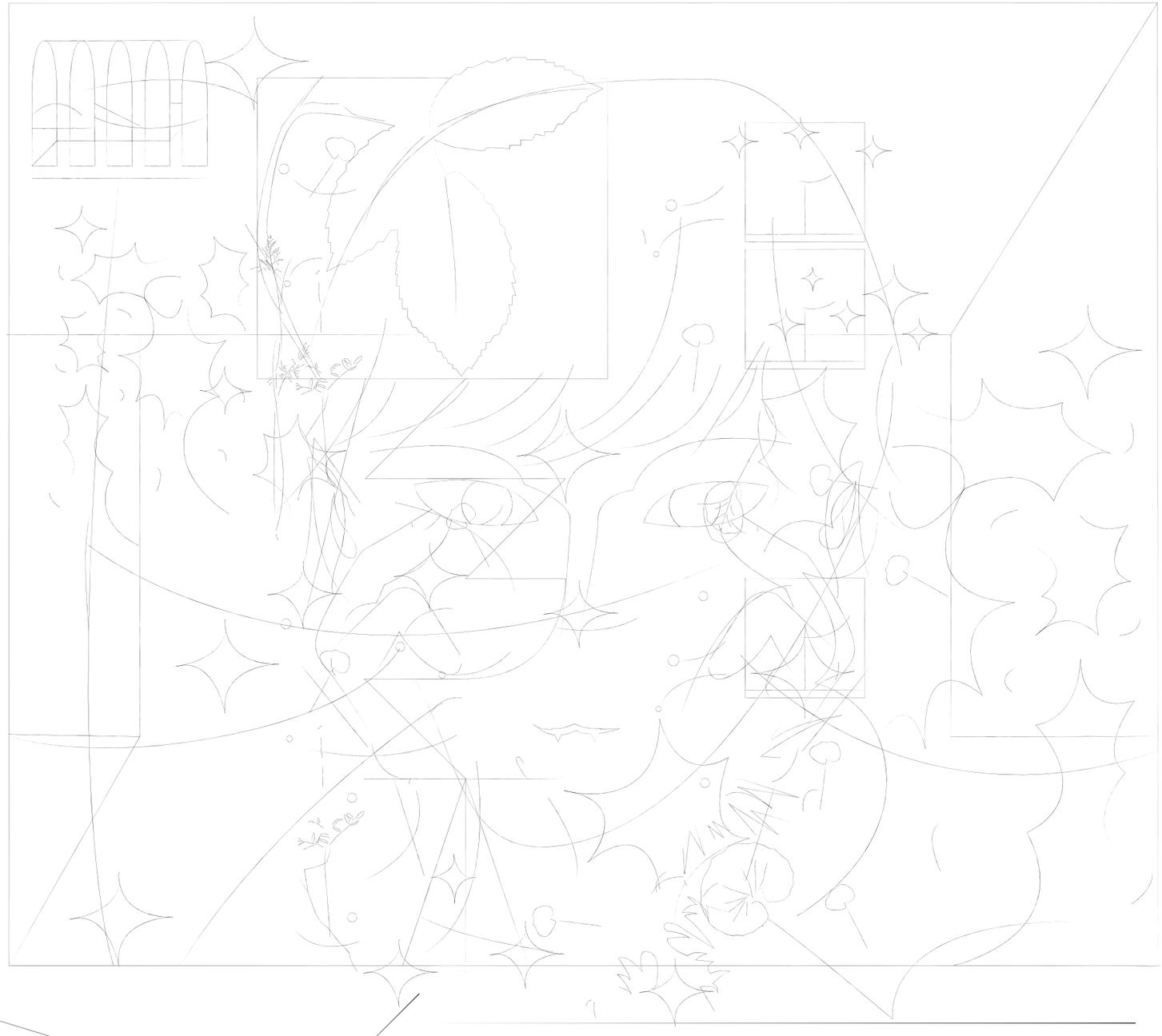
To that end, we thank the larger "we" of our family, friends, contributors, Kickstarter community and beyond—your generosity and support has enabled us to create a platform to share these world-changing ideas.

To the future!
LinYee and Johnny

DESIGN FOR THE OTHER 90%

TEXT BY JAVIER HUNT
ILLUSTRATIONS BY DANNY ESPINOZA

Paris in the 19th century was a cesspool. Literally. Small, winding streets admitted neither sunlight nor fresh air. Carcasses of dead horses lined the streets, and clean and polluted water sloshed together in the primitive sewer system, leaving regular outbreaks of typhus and cholera in its wake. Into this morass marched Georges-Eugène Haussmann, Napoleon III's erstwhile city planner who was, to put it mildly, resolute in his determination to clear out the sclerotic streets, straighten boulevards, demolish slums and make Paris safer for the bourgeois lifestyle that was struggling to flourish. Haussmann's ambition in routing out the clogged streets was two-fold (at least): to widen them enough to allow Napoleon's army to successfully overwhelm any barricades that political resistors might erect; and, buoyed by the work of the French Hygienics movement, to provide safer sewers, cleaner water and fresh air for the sickly, teeming masses that he was simultaneously displacing. Haussmann, a proto-Robert Moses, reshaped modern Paris at a scale that only an architect like Le Corbusier could dream of—and did.



In Towards a New Architecture, Corbusier's 1923 manifesto for future habitation, he builds upon Haussmann's hygienist legacy. Best known for its proclamation, "A house is a machine for living in," the lines that immediately follow are equally revealing, "Baths, sun, hot water, cold water, warmth at will, conservation of food, hygiene, beauty in the sense of good proportion... We must clear up a misunderstanding: we are in a diseased state because we mix up art with a respectful attitude to mere decoration." The aesthetic imaginary that Corbusier was forming during his years in Paris certainly focused on the architectural qualities of mass, line and surface, but buried within was also an agenda of moral and physical cleanliness that owed a deep debt to Haussmann and the Hygienists.

Looking back, however, there is a very different way to read these passages: as an early salvo in the design profession's century-long campaign to interleave aesthetics with the elimination of microorganisms. Design, it seems, has a long history of violence when it comes to the elimination of germs. Eradicating germs was, of course, the prevailing science of Corbusier's day, influenced by Pasteur's discoveries. Corbusier's espousal of abundant light, circulating air, sterile surfaces, bare floors and no decorative nooks and crannies to harbor little bugs certainly abetted that epidemiological objective. But we are now discovering a new, inconvenient truth for design: that most of those targeted microorganisms, in fact, play a beneficial and even essential role in our good health. That is, the emerging research around our microbiome—those hundreds of trillions of bacteria, fungi, protozoans and viruses (as well as their genetic material) that live in and on the human body—suggests that those antibacterial, "clean" surfaces put at risk colonies of germs that we might actually need to stave off a slew of autoimmune disorders. All of which raises a critical question: given that design has been an active agent in a modern war on microbes, what is its responsibility from this point forward?

What does a design future look like that fosters the restoration, growth and even flourishing of microbial cultures? First of all, we must still distinguish the pathogens from the mutualists and symbionts. While the vast majority of almost all microbes are beneficial or at least benign, there are still plenty that can kill. So it is cavalier to simply leap toward an equal and opposite reaction. But the first lesson that we can take from these discoveries about the microbiome is a gloss on one that we have been learning over and over for at least fifty years: that we are not just part of a larger ecosystem, we are an ecosystem. Roughly ten percent of the cells by number in our body are human, the remaining ninety percent belong to tiny others who comfortably share our bodies and skin. This is not just a startling fact, but a Copernican shift in how we understand who we are. I am not I... but I/we are a cohabitating culture of mutually interacting entities that tussle and cooperate for preeminence over a lifetime (and the microbes always win out in the end). We are not just part of an ecosystem...an ecosystem is part of us. That fact must influence our design decisions moving forward.

What are the emerging frontiers, then, in this new and vast campaign of truth and reconciliation with the microbes? There are four areas, at least, where designers can develop new frames, new methods and new ideas:

IDENTITY

How will we adapt our understanding of our own selves to account for the 100 trillion microbes that comprise us? What services will we design to foster their resilience and how seriously will we challenge a notion of subjectivity that has been with us for hundreds of years if that egocentrism is inadvertently undermining our own well-being?

PROPERTY

Our microbiome is both of us and not of us. Yours might be more robust than mine, or ours. Mine might affect yours... or my home environment might alter yours. One person's dirt might be another's salvation. How are we going to manage the massive, multidimensional ecosystems that both belong to us as individuals and belong to everybody as our ecological commons?

HYGIENE

How can we reframe "clean" for an age where filth, grime and invisible creepy crawlies might very well be our saviors? How will our interiors, our kitchens, our bathrooms, our restaurants and our clothing need to evolve in order to welcome our symbiotic friends while still keeping at bay their pathogenic relatives?

DIVERSITY

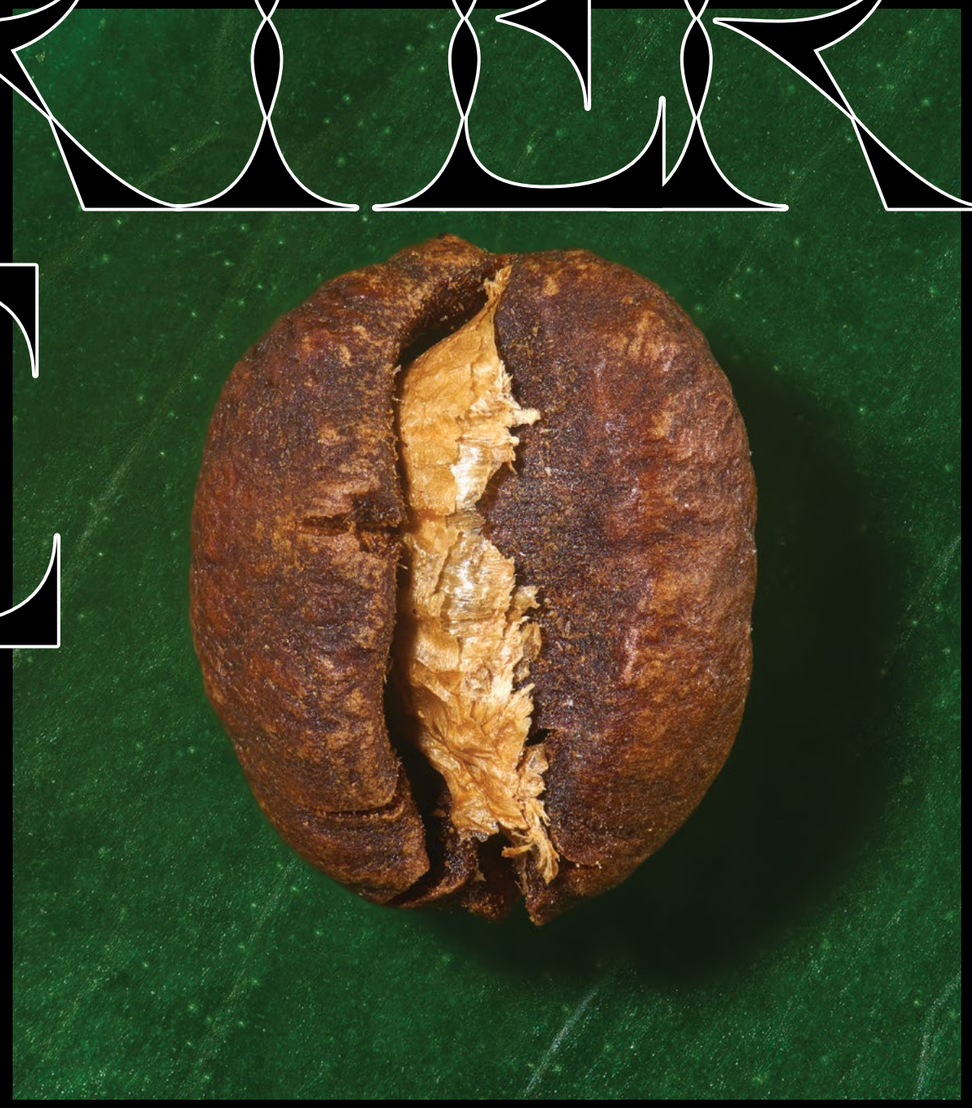
How can we create the tools and visualization strategies necessary to communicate back to ourselves the relative health and diversity of our own complex microbiomes? What combination of modern medicine, data visualization, wearable (edible?) sensors and visual displays will it take to help us keep track and even increase the resilience of our microbiome?

Design is a practice with high moral and political stakes, whether we choose to admit it or not. Unanticipated consequences will always be part of making the "new." But we must now move forward alongside an emerging body of research that makes urgent an increasing interdependency with our microbial communities. We/they can no longer pretend we are alone in this struggle. Our mutual self-interest is at stake.

A SMARTER COFFEE

PERSPECTIVES:

AFINEUR



FROM TO BIOTECH

BEAN MAGIC

Among the more unusual phenomena in coffee connoisseurship is what is known as KOPI LUWAK, Indonesian for "civet coffee." If the name imparts a sense of exoticism, it also elides the gross out-factor:

INTERVIEW BY RAY HU
PHOTORAGPHY
BY COREY OLSEN

THE BEANS ARE
HARVESTED FROM THE FECES
OF THE CAT-LIKE CIVET.

The animal's appetite for coffee cherries transform and smooth out the flavor of the beans as they move through its digestive tract. The easy joke about "one man's trash" — or in this case, one animal's poo — belies the actual process, which is essentially a form of fermentation.

This insight inspired a pair of French scientists to investigate this biochemical process in the lab. Camille Delebecque and Sophie Deterre founded Afineur in Brooklyn in 2014, launching their first product, Cultured Coffee, in December 2015 with a successful Kickstarter campaign.

We had the chance to speak to Delebecque about their background and business model, the distinction between technology and craft, and what the future holds for fermentation—not just of coffee beans but food in general. Here's what he had to say:

An Asian palm civet cat. Civet-digested coffee beans go for more than $600 a pound; Afineur's lab-cultured beans cost $69 a pound.

Sophie and I first met 18 years ago in high school but we took our own paths. Sophie did an engineering degree in food science and then a Ph.D. in flavor chemistry understanding which molecules contribute to what flavors in food. As for myself, I did a Ph.D. in biotechnology and microbiology, focusing on getting microbes to do new, interesting stuff.
The applications I was looking at at the time were mostly around biofuels, but I was always interested in the cool stuff that was happening in biotechnology labs, even though there's always been a big gap between academic research and applications in the marketplace. And I've always been interested in food — I was raised in a family that spent at least an hour every night to cook a nice dinner.

When our paths crossed again about two years ago, we realized there was something really cool at the intersection of our two areas of expertise: microbiology on one side and food science and flavor chemistry on the other side. Fermented food has been around for a long time — based on the discovery of cheese-making tools in Holland, the first cheeses were made at least 7,000 ago — but in the past five to ten years, we've gained a much greater understanding of what microbes can really do. That's what we try to capture with Afineur — to really transform what used to be kind of a spontaneous and uncontrolled process into a precision editing tool to change not only the flavor but also the nutritional profile of food products.

Natural, spontaneous fermentation plays a role in coffee processing in some parts of the world. After coffee is harvested, they dunk it into water to get rid of the pulp around the bean—some microbes grow spontaneously and chew away at this pulp. Our consumer base was somewhat familiar with the importance of fermentation in these craft coffee products, and I would still call what we do "craft coffee." I think where we shine is really at this intersection of craft food and technology.

We thought coffee was an interesting product to start with for a number of reasons,

most notably that we're at a transition known as the third wave of coffee—a shift towards higher-quality coffee. People are changing the way they consume coffee and it's become a gold rush for high-quality beans. In the coffee industry, sourcing and roasting are really the only tools to control the quality of the coffee. Fermentation brings another level of creative control.

We are trying to achieve two different things with coffee: first, we want to achieve very smooth coffee profiles to erase all of the bitterness and astringency of traditional coffee so the more interesting notes of terroir shine through. We also want to neutralize the profile of coffee and position ourselves like a health and wellness product. A lot of people want to limit their coffee consumption or switch to other products like tea because their stomachs are sensitive to coffee — we've reduced all of the molecules that are responsible for that.

We are looking to vertically integrate the business: not just looking for technological solutions but also thinking about commercialization. On one hand, we get to understand and identify with our consumers, but on the other hand, we get to tell a complete story about both the coffee and the technological process so we're not hiding behind the science. We use the process, design and packaging as an opportunity to educate consumers about the wonderful world of microbes and what they can really do (or not do) for food.

The bigger ambition of Afineur is really to leverage natural fermentation to unleash the full potential of the process for different food products, and we see a lot of opportunities to develop an interesting consumer brand around smart fermentation.

REVISITING A SCATALOG

PERSPECTIVES:

TEXT BY
ALEXANDRA DAISY GINSBERG

REVISITING A SCATALOG: In 2009, an aluminum briefcase filled with six rainbow-colored plastic turds traveled from London

[...] to Boston for the International Genetically Engineered Machine (iGEM) competition. The briefcase contained the *E. chromi Scatalog*, a speculative design project set 30 years into the future when consumers would be able to buy a probiotic yogurt containing engineered "*E. chromi*" bacteria that would detect chemical signals and diseases in the gut to produce feces of corresponding colored output. Colored poop would be a provocative conversation-starter in any setting but the iGEM competition is a unique gathering of scientists and engineers who are inventing the nascent field of synthetic biology.

For designers Alexandra Daisy Ginsberg and James King, graduates of the Royal College of Art's Design Interactions masters program, the *Scatalog* represented months of wrestling with questions in synthetic biology, big and small, with a team of undergraduate students from the University of Cambridge and the project was an opportunity to present a case study in how designers might work with scientists and engineers to help define the field.

Eight years after its introduction, Daisy Ginsberg revisits the project's impact on synthetic biology and raises questions about whether engineering living organisms fulfills the promise of a better world by design.

When we first proposed the *Scatalog*, I had spent a year and a half thinking about synthetic biology. At the time, the field was using machine and computer imagery to represent their ideas, so electronic circuits and cogs. Having spent some time in the lab with the Cambridge students who were engineering bacteria to produce colored pigments for iGEM (which we called *E. chromi*), we were struck by the wet, biological nature of what we were working with and how in synthetic biology there seemed to be a coyness to talk about the actual living material. We thought the gut suggested a really interesting future computer interface that tapped into a few different things.

One was aesthetics: if you don't want to design with a biological aesthetic (and what is that?), then what will synthetic biology do? Confronted with the gut as a design space, were people squeamish? The second part was a provocation. We set the *Scatalog* in 2039 to talk to the scientists about when it would be possible to do this. Drew Endy, the Stanford synthetic biologist, was adamant that it would be technologically possible much sooner and he may be right, but we wanted to discuss when would it be culturally acceptable? Could a biological design ever be stable enough to be relied on for this kind of function? We talked with the students about how a consumer probiotic yogurt that could detect disease could even change the structure of healthcare provision.

That's how we try to get designers and synthetic biologists to think on this different scale of implications, rather than just applications. For example: If you could go to the supermarket to buy healthcare, you'd check your poo every day. Would you become more neurotic, thinking that maybe you had cancer? What happens with false positives or negatives? How would you design something that's so stable that it wouldn't evolve in your gut? If you are relying on a technology to tell you if you have a disease, how reliable does that technology have to be? But now there are companies starting up in this space, like Synlogic in Boston and I'm really curious how they deal with the evolution of designed, living things.

In 2014 Jonathan Kotula, now Synlogic's lead synthetic biologist, wrote a paper about engineering programmable bacteria for the gut. The funding came from a DARPA call to find ways to protect American intellectual property in an emerging global bioeconomy. Programmable bacteria open up the idea of internal surveillance: a fascinating new space raising issues around ownership of designed, living things inside your gut that can record signals. If you poo out engineered bacteria that are designed to reduce ammonia levels in the bloodstream, something that Synlogic is working on to treat a debilitating genetic disorder, how does that bacteria live in the waste stream, in the sewer and beyond? Who is going to control or set up the legislation up for those things?

Designed probiotics seems like a magic pill but there are many issues that are really intriguing to think about — from surveillance to contamination, evolution to ownership. The jury's still out on whether things like the probiotic drink Yakult, which was originally isolated from someone's shit, actually do anything. So would adding an engineered bacteria that you would take every day make a difference? How much of it would you have to ingest? There's so much complexity around the microbiome and we are still learning about how these communities of bacteria live together.

The microbiome, whether the skin or the gut, is not an isolated context to design in: it connects us, inside and out, with the spaces we inhabit. It's fascinating to think about the microbiome and how we might control it. Will designing it make it better? I don't know but I don't think it has been discussed from this perspective in depth yet. It's a new space for design.

PHOTOGRAPHY BY LOUISE HAGGER
STYLING BY OLIVIA BENNETT

BUTTER

PERSPECTIVES:

DIARIES

INTERVIEW BY JOHNNY DRAIN

BUTTER DIARIES

Grant Harrington's cultured golden-yellow butter, served at myriad Michelin-starred restaurants in the UK, is some of butteriest around. We caught up with Harrington about the wonders of butter and his creative process.

JD Do you have strong memories of butter from your childhood?

GH Not really! I grew up in the time when butter was deemed incredibly unhealthy for the consumer; but as a real treat, sometimes, we'd have Kerrygold on ham sandwiches at my Grandma's. So you can imagine my surprise working in my first Michelin-starred restaurant at 19 where butter was literally thrown into every aspect of French cooking.

JD What first got you interested in making butter?

GH Having worked as a chef for a few years, I knew how much of a necessity it is in the kitchen, but my world was turned on its head when I started at Fäviken (Magnus Nilsson's two Michelin-starred restaurant) in Sweden. The butter was so-well-buttery! That's where my butter journey really began, and my fascination with the art of capturing the moment that a product has maximal flavor, or fermenting it to achieve this: peas plucked straight from the pod in their ultimate prime, cattle that's carefully aged until it tastes incredibly beefy, or sauerkraut that's insanely "cabbagey" are good examples.

JD Is focusing just on butter dramatically different from working as a chef? What do you miss about being a chef?

GH I feel as though my cooking career has embedded in me the importance of focusing on ingredients, their

characteristics and their quality. In those first jobs in London, a massive variety of ingredients was available and abundant, and the focus was on evoking surprise from and deliciousness for the diner through that variety and the resulting flavors. In contrast, when I moved to Sweden, the focus switched to harnessing and creating as much flavor as possible from each and every ingredient around you, even though there might not be many! That transition's made me something of a minimalist, but it's a solid fact — underlined by my time at Fäviken — that a dish can only ever be as good as the ingredients it's made from.

JD How do you go about "designing" a new butter? What are your aims, what's the process you go through?

GH I don't think you design a new butter, "Butter" by definition—for me at least—unless specified, refers simply to the solid fat that can be separated from cow's milk. My single aim is to make that solid yellow fat taste as intensely buttery as possible.

JD Was designing your butter like creating a dish for a restaurant?

GH Not really! For me, a dish is defined by having multiple components, whereas with my butter, I am focusing all my efforts to make this single component perform at its absolute peak.

JD What's your current butter-making set up? What are the sights and sounds: I know you're a big Sigur Ros fan, do you listen to them while making your butter?

GH Just over two years ago, I designed and built a kitchen cabin on Lords Farm in Oxfordshire with the sole goal of making butter in it. I have a large French-style churn, and great refrigeration and fermentation capacity. The only downfall of planning it so efficiently was that I didn't treat myself to windows, so I don't see the beautiful farm landscape that I'm surrounded by; just yellow, all day, everyday. But I love it.

I am a huge Sigur Ros fan but often keep the music a little more upbeat, say Paul Simon, when I'm being productive and not fermenting

JD And what's your workflow like?

GH It's top secret!

No I'm kidding... Early Monday morning my cream is delivered from a select few Jersey herd farms nearby: I use unhomogenized, pasteurised cream so the particular lactic acid bacteria I ferment it with can produce the specific flavor I want: it's like a painter starting with a clean canvas. As soon as it arrives, I begin fermenting it in a large tank. The inoculation period usually lasts up to two hours, then the cream is moved to vats and kept at a slightly lower temperature until it's churned, 158 hours later, on Sunday evening.

Tuesdays, I deep clean the cabin, and shape, portion and package deliveries for the following day. Wednesdays, I deliver to Warwickshire and Nottingham, send butter via courier to the South, Scotland and Newcastle, and, if I get a chance catch up on emails and accounting! Thursdays, I prep more deliveries, which I deliver to Oxfordshire, Buckinghamshire and Gloucestershire on Friday. On Saturday, I take the rest down to London and sell the butter at Druid St Market, just south of the river. Sundays, I'm back on the farm, churning the cream once it's reached peak flavor and hand-salting the resulting butter.

JD What's your favourite type of cream and why?

GH Whatever's closest to me: I believe that terroir plays a huge emotional role on a diner, so I will always prioritize cream from cows that are closest, and that have the highest ability to digest beta-carotene and produce butterfat-rich milk: that creates the most vivid yellow butter. Lucky for me, there are Jersey herds local to me.

JD And your favorite bacteria?

GH Now that is top secret!

JD Seasonality has become a big buzzword in recent years, but most of us don't see its effects in the dairy products we consume most often. Does it make a big difference?

GH Everything a cow grazes effects her milk output, be it from the beautiful meadow flowers, abundant in fields in spring and summer, to the grains and silage (fermented grass) that are usually available to cows throughout the wetter seasons, which they pretty much stampede over to get to! These differences emerge noticeably—in color and flavor— the way I, and others like me, work.

JD Aside from your own work, what's the best butter you've eaten, or best butter experience you've had?

GH The butter at Fäviken is phenomenal.

ARTWORK BY MIKEY JOYCE

A BIT OF URA IN AGLASS

PERSPECTIVES:

TEXT BY
ISABELLE LEGERON, MW

THAT CRAZY FRENCH WOMAN on the Beauty and Bacteria of Natural Wines

ISABELLE LEGERON is France's only female Master of Wine and the winner of the Madame Bollinger award for Excellence in Tasting, the Villa Maria award for Viticulture and the 'Wine Woman of the Year' award in Paris. She created RAW WINE, the UK's largest artisan wine fair, which has since expanded to an annual event in Berlin and New York.

Natural wine is about preserving life from the vineyard, to the cellar and into the glass. I mean that quite literally — natural wines are full of life. If you've ever looked at wine under a microscope, it speaks for itself! Because life is fundamental to what makes natural wine so wonderful, you cannot have natural wine without organic farming and a vineyard that pulses with the living. Indeed, if a wine is made naturally but not farmed organically, in the end it is just a low-intervention wine and nothing more.

Because great wine is all about great agriculture, my book is predominantly about farming and real, practical stories. I want readers to inhabit the skin of an Italian producer who makes phenomenal home-made bread or a southern French lady who heals herself with plants. They're not just winemakers — they're real people with real philosophies that go far beyond wine. My book is as much about a way of living — a belief in life — as it is about wine itself. When you drink a great bottle of natural wine and when you eat food with provenance that has been produced with respect, you feel nourished in a way that isn't possible otherwise.

My preference for natural wines is connected to my respect for nature — it's the only religion I know. I firmly believe that nature and the natural equilibrium of things is always better. When you let things ferment, the juice, yeast and bacteria do their thing all by themselves and the result is always more thrilling, more exciting and more authentic. It's a bit like hanging out with people who are very confident with who they are and don't try to be anything else — which is one of the most difficult things. I think the toughest journey is just to be you. With wine, it's the same.

I like the expression of natural wines. I like the fact that they evolve, that they mature. I sometimes find that conventional wines almost decay with time. There is a drying process almost like the drying of herbs — a mummification if you will. In the process you lose beautiful layers. When you make wines naturally over time, you actually preserve a lot of that freshness, but the evolution is different. Researchers now believe that this difference might be attributed to the bacteria in the wine. In any case, natural wines are capable of aging and real maturity, which is more interesting.

Surprisingly, many in the wine trade still believe that natural wine doesn't age well. Given the number of aged examples I have tasted, I know this is untrue. I was even lucky enough to participate in a blind tasting in the Jura with Pierre Overnoy which featured wines dating back to the '50s — all naturally made, farmed and completely sulfite free. I am so sure of natural wine's ageability that I make a point of cellaring a lot of wines myself and now have bottles which are 15–20 years old. But I am in the minority as most in the conventional trade wouldn't lay natural wines down, which sadly means there aren't a lot of examples to buy. One that you could get hold of—if your wallet allows — is a Domaine de la Romanée-Conti (DRC), which many do not realize is a natural wine. It is both naturally farmed and naturally made, they use very little sulfites (sometimes none at all) and it is a wine that famously ages well.

It's quite extraordinary because clean, healthy grapes have everything they need in and around the berry to become wine—complete nutrients, sugars, yeast and bacterial populations (which are everywhere). They have everything they need to create something that, with a little bit of guidance from the human touch, can produce extraordinary results. The key is to farm properly, so why take a shortcut? For me, I just love this idea that the berry, microbiology and life, has the potential of producing something so remarkable. Isn't that wonderful?

Sadly, we live in a sterilized world, where people are scared of all bugs. Anything vaguely unclean is banished and that's a shame. As HRH Prince Charles said when the EU threatened to ban unpasteurised cheese: "It should strike terror into the hearts of any true born Frenchman... and all other people...who find that life is not worth living unless you have a choice of all the gloriously unhygienic things which mankind—especially the French portion of it—has lovingly created." Luckily, a revival of fermented foods has begun, but I'd love to see more people take it up themselves. After all, you can definitely do it yourself at home. Instead of grapes, experiment with cabbage or other vegetables and ferment by squashing them down to release their juices, add a little salt and bingo: sauerkraut or kimchi will be born within four or five days—or months—if you're willing to wait and experiment.

With wine, naturally made, it's pretty much the same thing. You literally drink life from that particular vineyard. There is a population living in every bottle. You could open a bottle in New York and you would literally be drinking a slice of life from a little spot in France, Spain or Italy. You don't get that with conventional wines which have been disinfected in a way. I just love the fact that I can open a bottle of natural wine and have a little bit of Jura in the glass.

PHOTOGRAPHY BY COREY OLSEN

Excerpt from *Natural Wine*. CICO Books, 2014

THE SCIENCE

Three recent-ish scientific studies are a further testament to this "living-ness" and its ability to continue for decades, if not centuries. Firstly, in 2007, the *American Journal of Enology and Viticulture* published research into the "Survival of Wine Microorganisms in the Bottle During Storage." Having explored a selection of Bordeaux wines across various vintages, with the oldest dating back to 1929, the team found that most of the older bottled wines contained elevated yeast populations. In fact, a Pessac-Léognan bottled in 1949 contained 4 million cfu/ml (meaning colony-forming units per milliliter), which, according to the authors, amounted to between 400 and 4,000 times as many as the average microbial population found in many pre-bottled wines today. They also found that 40 percent of the bottles contained lactic acid bacteria.

Then, in June 2008, Professor Dr. Jürg Gafner, of the Agroscope Wädenswil Research Institute in Switzerland, explored the microbiology of a selection of Räuschling whites, the oldest dating from 1895. To the surprise of many, he isolated six different, living, dormant yeast strains across the various vintages, including three from the oldest.

Finally, and perhaps most remarkably of all, a Jurassien vin jaune ("yellow wine") from 1774 was tasted some 220 years later by a group of local experts, who described it as "nutty with notes of curry, cinnamon, apricots, and beeswax with an exceptionally long finish." According to microbiologist Jacques Levaux, who later tested it at the laboratory, both bacteria and yeast were found and, although dormant, they were still very much alive.

The bacteria, in particular, may hold an interesting secret, as Dr. Karin Mandl from the biochemistry division of the HBLA und Bundesamt für Wein- und Obstbau, in Vienna, explained to me. Although still at the very beginning of her research, Karin is trying to cultivate bacteria found in various wines in the hope of isolating a strain responsible for wine's ageability. Gilles Vergé, a natural wine grower in Burgundy, is also convinced: "Without bacteria, wine cannot age. It's they that keep freshness going even in very old wines. They can continue to evolve for decades, if not centuries," he says. "They don't need much to survive, just the trace sugars that remain after fermentation."

THE BENEFITS

So life is key, not just for growing grapes or for fermentation, but also perhaps for wine's potential to grow old gracefully. This is not to say that only natural wines contain life—after all, all wines are made with yeasts and bacteria (whether indigenous or not), so, at some point in the process, all wines must have been alive. It is just that natural wine is a lot more "alive" than the rest. Many conventional wines will include microbe populations, but how many depends on multiple factors, from agricultural practices through to the processing and additives used in the cellar. Extreme filtration, for example, may well have been the main reason why there wasn't any yeast in sight in the store example photographed by Laurence.

By impacting on the microflora, these artificial interventions also seem to have an impact on taste. "Chemical wines are like a flat line," says Saša Radikon, whose family has been making sulfite-free wines in the Collio, in eastern Italy, since 1995. "How long the line is depends on how good the enologist is but, fundamentally, it's a flat line that suddenly comes to an end. Natural wine, on the other hand, is like a giant wave. Sometimes it shows well, others less, and, like all living things, it will eventually die, but it might be tomorrow or in 20 years' time." This, Saša explains, is intrinsically linked to the life inside the liquid, which is noticeable throughout the year. "Our cellar is not temperature-controlled, so it moves with the weather. In winter, when things are slow outside, the wine is slow too. Then, in spring, when life picks up again, so too do the wines. They have more flavors and they taste different. Then back to fall, winter, and to sleep again. The wine is definitely alive."

Proper living wine is, literally, a kaleidoscope of taste. Try it today, and it will show certain aromas; taste it tomorrow, and it will be different. These are wines with an ever-changing, extraordinarily complex aromatic profile that functions a little like a child's mobile—different parts rotate individually, showing themselves differently at different moments, so that the whole is never the same twice. Sometimes open, sometimes closed. Sometimes giving, sometimes not. It is almost as though the microbiology needs time to wake up and react, or simply chooses to sulk in the corner.

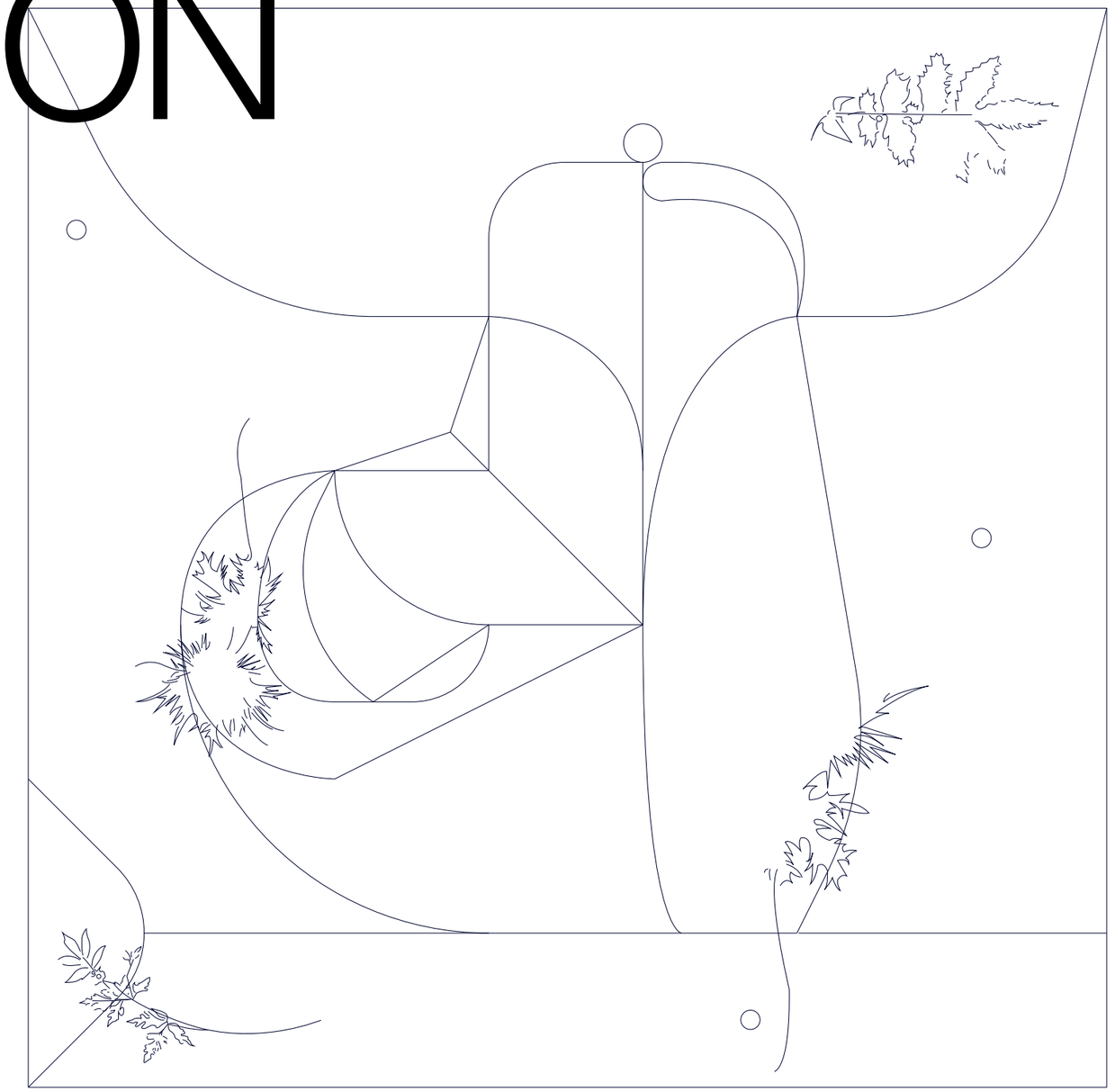
Just as we are beginning to talk about the "second genome" or the fact that, as humans, we are so much more, biologically speaking, than just an "I"—as bearers of genetic information, we're more than 99 percent other stuff as well, according to Michael Pollan of *The New York Times*—so, too, wine is more than a simplistic combination of organoleptic compounds, alcohol, and water. It contains "other stuff" as well. And, like our other stuff, that of wine also lives, protects, defends, conquers, grows, reproduces, sleeps, ages, and dies. This is fundamental to what makes wine wine, rather than a simple, sterile, manufactured alcoholic drink.

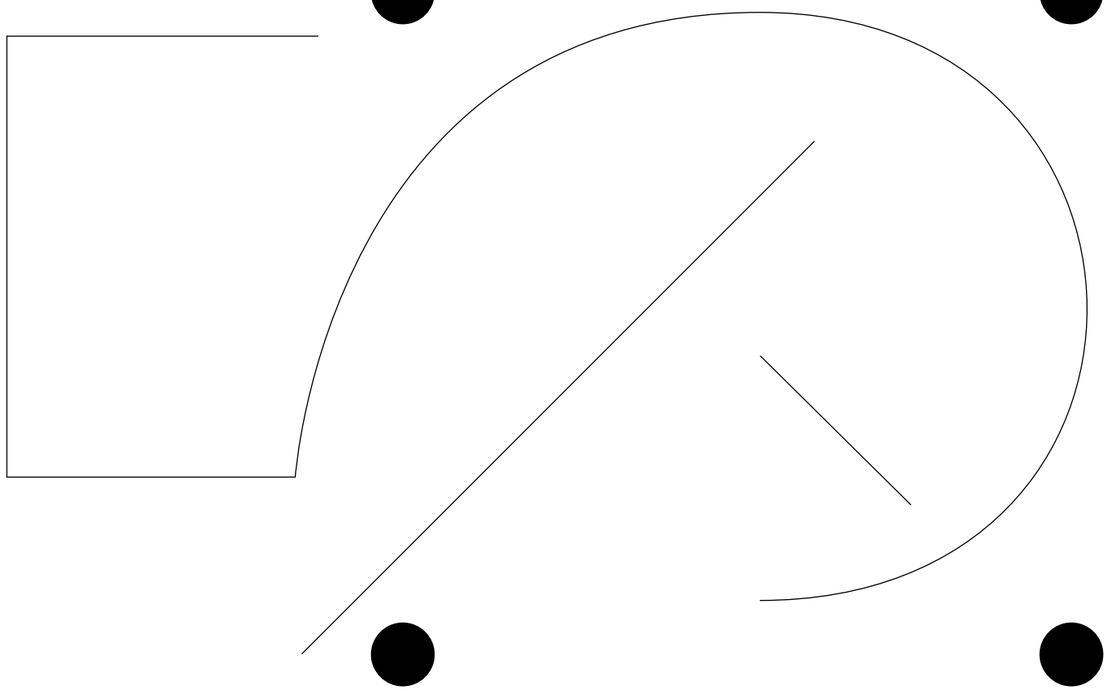
— ISABELLE LEGERON

CULTURE: MEDITATIONS ON FERMENTATION

BY KWANG UH (BAROO)

ARTWORK BY DANNY ESPINOZA





My first memory of fermented foods can be traced back to my first taste of food. Being lucky enough to be born in Korea means exposure to fermented foods from an early age. It's an essential element of Korean cuisine; foods like soy sauce and fermented bean paste are used in lieu of salt. From our agricultural and geographic roots sprung a diet of preserved wild plants seasoned with fermented soy beans and condiments to balance the need for proteins.

My work in kitchens around the world shaped my approach to the food we make at BaRoo. Working in restaurants in New York City made me consider the fundamental importance of discipline and how basic technique provides the backbone of cooking. It was tough—I was a beginner—but these experiences introduced me to the foundations of the restaurant business and a broader view of food. In Italy I learned about how food is influenced by culture from an anthropological and sociological point of view. This way of understanding gastronomy continues to shape my approach to food and therestaurant. *Staging* in different countries allowed me to have a deeper appreciation of how cuisines develop and progress within their own cultures. By keeping this question around food and culture at the forefront and trying to understand the how, what and why, I've been able to think more deeply about how various ingredients—indigenous or not—can be used differently when paired with a specific technique and influenced by history.

Certain fermentations create glutamates which triggers the taste of umami. This flavor really differentiates fermentation from any other type of cooking—fermentation can be wild, natural and uncontrollable. These same factors create challenges and difficulties which is part of the joy of cooking this way. The true charms of fermentation and why it's so important to the cooking we do at BaRoo include the unexpected outcomes and variations that result in glutamate content. But oftentimes it results in failure—fermentation is challenging because of its uncertainty, sometimes even when executed within the same controls. In fermentation, the cooking is mainly done by nature whereas conventional ideas around "cooking" center around people. Perhaps all cooks should keep this in mind—we are a mediator between nature and people through food. Fermentation

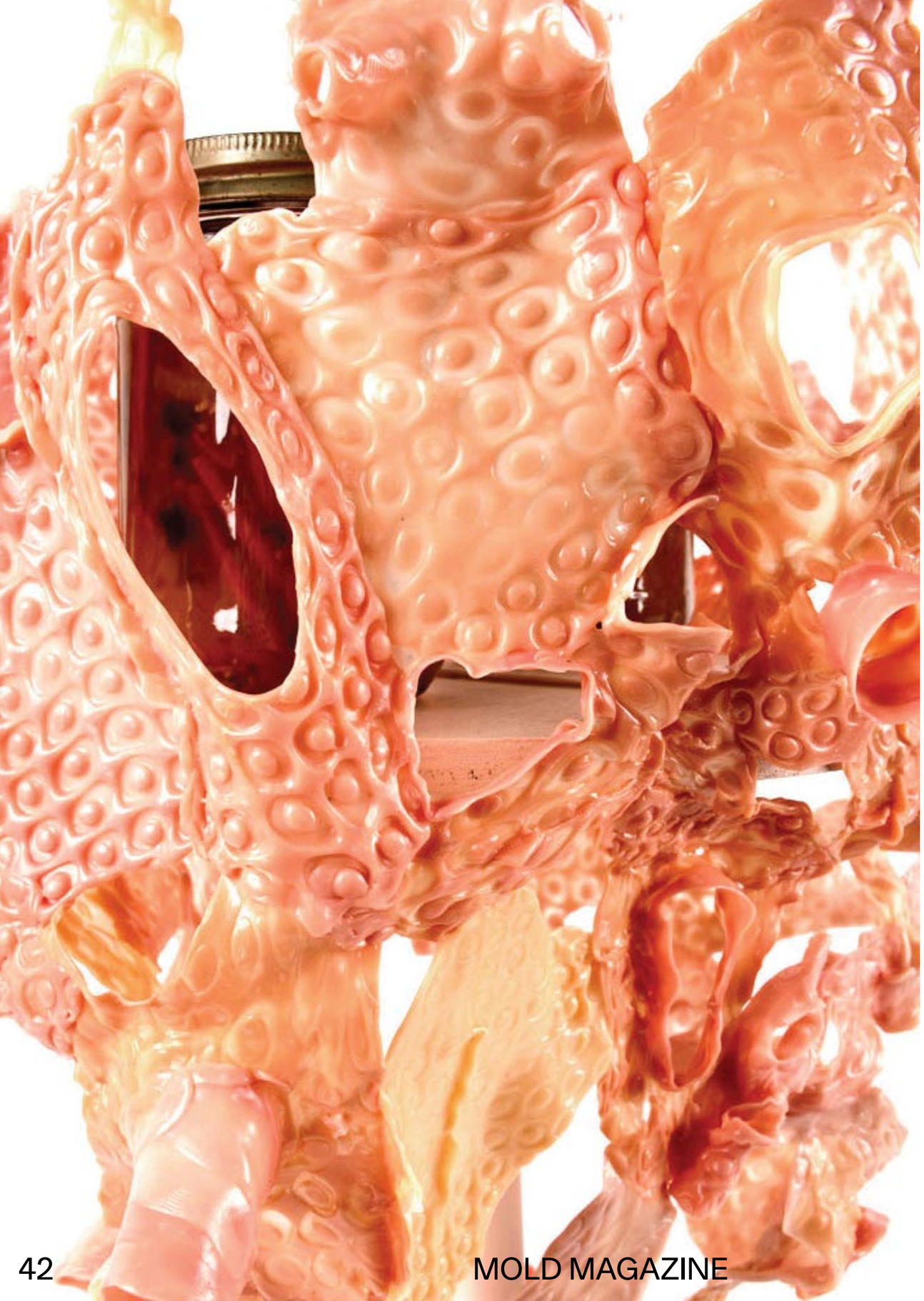
is executed by the natural world with the ingredients themselves and people are just the custodians—caretakers guiding the process.

Fermentation is almost like raising an animal, plant or person—you have to do so with care, affection and love. If any of these factors are missing, it will create a wildly different outcome. For example, when cultivating *noorook* (koji), as in one's own life, you have to keep a keen eye on the balance, checking for temperature and humidity throughout the process. If the fermentation period is too short, it can taste immature; fermented for too long, it can become rotten with the mold. When matured in the right way, the taste and the flavor deepens—similar to how humans age with wisdom as time goes by. Even a small moment can entirely change the direction of one's life—the butterfly effect. With some exaggeration, various factors in the fermentation process are mirrored in the progression of the life of human beings.

Fermentation is the accumulated wisdom of human history and functions not only as a preservative, but can enhance the taste, texture and nutritional value of foods. Most importantly, it can chemically break down inedible compounds in foods—in the future we might ferment weeds, soil or unimaginable byproducts that emerge from new technologies, or synthetic, genetically modified foods.

Thanks to the industrial revolution, human consumption and agricultural production has become extreme. Land is being sacrificed for feed crops to raise cattle, compromising local ecosystems. We waste so much food on a daily basis—including parts of

produce that have been used and consumed in the past—because of the wealth brought on by industrialization. Our land and environment change day to day due to overuse, pollution and mass production. The United States consumes more meat per person than any country in the world and our taste for meat seems insatiable—many experts predict an imbalance between demand and consumption of food while people are suffering and dying from hunger around the world. For these reasons, there have been great efforts to develop insects and engineered foods that can replace the foods we currently eat. Who knows what the future might hold. With pharmaceutical companies buying agriculture companies, could this usher in a new era of synthetically created pills as meal replacements? Medicinal pills from bugs? Wild plant synthetics? VR-enabled experiences to replicate the satisfaction of real food? In a world where fresh produce is limited to the privileged, fermentation could be used as a new technology to help feed the masses.



THEY, THEM, THEIR
S.E. NASH CREATES A VISUAL LANGUAGE FOR FERMENTATION

Text by Jon Santos.
Collaborative collage illustrations by Jon Santos featuring the work of S.E. Nash.

I met Nash in 2006 at Yale during the Senior MFA exhibition in New Haven. The artist was showing a series of scale models and other sculptural works that reminded me of how architectural works can evoke an expression of internal inquiry.

Later that year I asked if Nash would contribute to a publication I was curating and publishing called *Resurrection* which asked artists to literally bring something back from the dead. Nash re-engaged with a body of work concerning lesbian historiography based on earlier works where the artist painted graphic representations of fictitious historical lesbians that questioned the necessity of constructing an authentic lesbian history around 'real' lesbians.

Those paintings included an anarchist lesbian librarian and a lesbian frontiersman. The representations were alterations of photographs: one is from Smith College in 1890 and the other is a recent photograph from Tiananmen Square. Both photographs perform same-sex attraction for the camera—one is an attempt to normalize the appearance of that attraction and the other to scandalize it.

As time passed over the last decade, Nash has been concerned with abstraction and the body and has created an arcing oeuvre that has moved from the external to the internal, much like the original works

I saw in New Haven. The current work is examining the body as an ecological construct—an unfolding and changing ecosystem of symbionts. In Nash's words: "Our relationship with microbes is not cursory: we need them to live, but we also need them to create the flavors we crave in our food. How we comprehend the activities of microbes on a daily basis is interpreted through perceptual signs of their presence."

In March of 2016, nearly a decade after we first met, I was able to drop in on an exhibition at Black Ball Projects in Williamsburg. Mingling on a table that would normally be reserved for some bottles of Chardonnay, Pinot and plastic cups there lay a nice spread of pickled goodness—a breach between art object and party favors. The ferments that had been bubbling and melding in the gallery were being served up: devouring them at the closing event was intended to be a symbolic harvesting of sculptures.

I looked around the room and checked out a few of the works that appear here. This presented a marked shift in subject but also a formal skew: sculptures that create a visual language for microbial activity in food fermentation. The works became reliquaries for a living consortium—a body for the ferment—where the digestion was on display.

I asked Nash about this shift. "Microbes and the microbiome provide an opening to probe fixed ideas of gender. If our bodies contain more microbes than human cells, then we are all 'they/them,' whether or not we choose these non-binary pronouns. In laboratory settings, microbes can be named and classified, but their certainty is not always guaranteed. Microbes can horizontally transfer genes and in effect, shape-shift to gain a new identity." The visual forms that Nash conjures in the sculptures reflect an improvisational, queer, non-binary and shape-shifting language.

"They/Them/Their" is a celebration of the multiplicity of being. It is a presentation of the actions and ingenuity of microbes: an attempt at de-emphasizing the human. The exhibition title refers to the artist's use of plural gender pronouns as a reflection of symbiosis. That we are made of more microbial cells than human cells means that we are all a multiplicity: we are all they, them, and their and can use these pronouns to untangle complicated notions of gender.

CULTURING YOGURT

0 Next Page:
Stacking yogurt vessel
by Yiyi Mendoza

Happy accidents have defined the development of the human culinary experience since the early days of our hunting, gathering and cooking. It is for this reason that some of the most mystical and alchemical transformations that take place in our kitchens cannot be traced back to a single discoverer or architect.

PHOTOGRAPHY BY
DAVID BRANDON GEETING

INTRODUCTION BY
ADAM FLABD

STYLING BY
PRISCILLA JEONG

In this regard, yogurt is one of the most archetypal preparations. While some speculate that it originated in the fertile crescent of Mesopotamia, the birthplace of agricultural civilization now known as modern-day Syria, Iraq, Iran and Turkey, whoever first harnessed the power of this metamorphosis over 7,000 years ago could scarcely have conceived of its subsequent and lasting impact.

At its core, yogurt, like most ferments, is an innovation that elegantly and deliciously deals with the universal issue of preserving a highly perishable food: this was especially important in the days before refrigeration. It just so happens that the process of fermentation also releases and creates constituents that make milk more digestible, nutritive, health-supporting and scrumptious. The beneficial bacteria that proliferate in the milk consume lactose—the disaccharide milk sugar—and create lactic acid. Moreover, their presence can compliment our own gut microflora in their on-going battle against pathogenic and opportunistic microorganisms.

The ingredients for yogurt are simple: milk, lactic acid bacteria—namely *Streptococcus thermophilus*, *Lactobacillus delbrueckii subsp. bulgaricus*, *Lactobacillus acidophilus*, *Bifidobacterium lactis* and other friends—heat (the milk is taken up to 170–185 °F for a moment, then held at 95–115 °F), and time (typically 4 to 24+ hours). Although staying within these parameters will likely yield desirable, edible results, anyone who has tried their hand at making yogurt can tell you that it does not *guarantee* them. There is as much art involved in the process as there is science. Commercial yogurt producers deal with this by attempting to control every variable to the smallest decimal place possible. Grandmothers and other community yogurt makers, on the other hand, achieve consistency by developing a personal ritual and a deep and innate sense of the process over the course of hundreds of batches. This ritual may involve a special vessel, a hyper-specific zone of incubation, or even a beloved cow whose milk makes better yogurt than that of her sisters.

To say that there are as many ways of making yogurt as there are cultures on this planet would be an understatement; every maker's touch and technique will differ. What's more, the diversity of roles that the thermophilic dairy ferment plays in the hearts of homes across the planet and the many ways in which it is integrated into myriad global cuisines is stunning.

However, the significance of this ancient technology is so much more than the sum of all the culinary and health benefits known and yet to be discovered. The most crucial facet of yogurt making, and that which will carry it far into our future, is that it prolongs and deepens the relationship we have with our food. As is the case with all food preparation traditions that take time and the passing on of knowledge, it connects us to our ancestors and allows us to become conduits between them and our descendants. More specifically, fermenting food allows us to engage with a dimension of our world that we cannot see with our bare eyes. It puts at the forefront the chief role of the beneficial microorganisms with which we live in symbiosis. For tens of thousands of years we did not know them but lived in awe of their work, attributing it to the supernatural. Now that we know them and have named them, we can still wonder at just how super and natural their work really is.

Adam Elabd is an educator inthe elds of fermentation, natural healing and nutrition and the author of a full length recipe book on fermentation: Fermenting Food Step-by-Step.

Yiyi Mendoza is a ceramic artist who expresses spirituality, the Mojave desert, Egyptian culture and her Mexican ancestry through clay forms.

A DRINK FOR OUR HEROES

TEXT BY SAMSON KIIRU (KENYA)

DESIGN BY TALA YUAN

1 NEXT PAGE: Russia: Quark Breakfast ceramics by Lera Moiseeva. Produced by Alissa Coe.

2 FOLLOWING SPREAD: Kenya: Calabash Bowl and Spoon by Tala Yuan for Steinbeisser.

When I visit the communities in the West Pokot area of Kenya, if I don't drink their ash yogurt, I feel like I haven't really been in West Pokot. It's such an integral part of the Pokot cultural identity: without it, they would cease to be.

Pokot ash yogurt is a bright grey, almost blue-hued, yogurt drink fermented in specially hollowed out and dried gourds. It gets its distinctive color from being mixed with burnt ash. One of its names, mursik, derives from this "mixing" but it's also known in Swahili as *mala kienyeji* and in Pokot as *kamabele kambou*. It's yogurty, with a sharp, sour taste, but the addition of the ash gives it a characteristic bitterness. The gourd also imparts flavor but it's subtle, aromatic and difficult to explain: most people can't quite put their finger on it.

It is a drink for special occasions—marriages, initiations, funerals—and for heroes. Without ash yogurt the Pokot don't consider an occasion special, nor could a hero be properly honored without it. So when I drink it, I, too, feel like a hero.

The Pokot are one of eight language-speaking groups that comprise the Kalenjin (or highland Nilotes), a tribe of around 5 million who are best known for producing an unusually large number of world-class and record-breaking long-distance runners. When these medal-winning athletes return from exertions, instead of wine they are given Pokot ash yogurt in a gourd. Likewise, when new army or police classes graduate, or when students pass exams, they are given it. It can be drunk on less auspicious occasions too: it's mostly made and drunk at home, but some cafes do sell it.

MAKING MURSIK

First, the animal must be milked! There are actually two types of mursik: one made from the rich, nutritious milk of goats, which is drunk by women and children, and another, for men, made from the milk of cattle. The fresh milk is boiled and cooled. Meanwhile the gourd, a calabash, is hollowed and dried and then cleaned and sterilized, using a palm tree leaf to brush burning coals around the inside of the gourd.

The cold milk is poured inside the gourd, closed, and allowed to ferment. After three to four days, the gourd is opened —carefully, because the build up of gases can cause it to pop. A well looked after gourd can be re-used, potentially for years and years. During the fermentation, the milk separates into watery whey-like material and the thicker, fattier part. The whey is drained and then ash, made from the wood of the cromwo tree, *Ozoroa insignis*, is added and the whole gourd is shaken and allowed to settle. Some communities add the ash before the fermentation but the Pokot add it at the end. Then the mursik can be drunk. The ash isan antacid, so after a heavy meal, a cup of ash yogurt can help allay stomach upsets.

The mursik can be drunk straight from the large fermenting gourd—the gourds are sipped from and then passed on, from hero to hero—or smaller gourds are hollowed, dried and split in half to make cups. It is often served with ugali, a Kenyan staple made from maize flour, millet and/or sorghum flour, similar to polenta.

Because the ash helps preserve it, mursik can remain edible for several months. Thus, during the drought season, or when pastures are in poor condition, the Pokot add hot water to their ash yogurt to reconstitute it to a milk-like substance, and Pokot herdsman take mursik with them when they are away with their animals because it can be consumed over the course of long trips without spoiling.

Samson Kiiru is coordinator of Slow Food Nakuru County, Kenya (southeast of Pokot).

Tala Yuan is a contemporary jewellery maker living and working in China. Her work reviews her understanding of the Chinese culture, while searching for her own identity.

FOOD OF THE GODS TEXT BY RAHUL SHARMA (INDIA)

3 NEXT PAGE:
Lebanon: Laban Yogurt Banquet ceramic by Nathalie Khayat

Yogurt is considered very auspicious in my country: in Hinduism, even the gods were fed with yogurt and sugar before they went to battle. Now, whenever you leave for an interview or something important which might bring some sort of judgement, a spoonful of yogurt and sugar is said to yield good results. When I was a student, my mother would give me this before I left the house for an exam.

She'd also make her own yogurt. Yogurt-making is a very domestic task and even now, with packaged yogurts on the market, many families still make yogurt at home. The yogurt of each household has a very different flavor. Whenever the yogurt at our house started turning sour, my mother would go to a neighbor's to ask for a spoonful of their culture. This practice is a compliment—there's happiness in the fact that someone would come to your door to ask you to share your yogurt culture.

In Hindu worship, there are five different things used to bathe the gods — usually honey, sugar, ghee (clarified butter), milk and yogurt, although we don't call it yogurt, we call it curd (it's different to what the Western world calls curd, which is basically what you use to make cheese). While yogurt is very much part of our culture, it starts with milk. People around the world might laugh at the fact that beef is banned in our country, but the basic philosophy behind the beef ban comes from the milk. When a child is born, the mother feeds the baby with breast milk. But after a certain age, the milk that you drink comes from a cow. From that point on, your "new mother" is the cow. How could you eat your mother? That's why we consider the cow to be very sacred.

A few years ago I got a grant from Noma to attend their MAD Symposium and visit the restaurant for ten days. It was a complete fan boy moment for me to see so many great chefs around—I didn't know which chef to run to and talk to first. It was through this experience that I started to more clearly understand how important each ingredient is. Around this time, I was also studying the history of tomatoes in our cuisine. Indian cuisine uses a lot of tomatoes but they are not native to India. Spanish traders brought them into our country in the late 15th century and used them to barter for spices. Before that, the major ingredient for Indian cuisine was yogurt, which Indian chefs would use to balance out the sourness in food. This was later replaced by tomatoes. This research came as a big shock because, for me, without tomatoes life doesn't exist.

At Masque, the restaurant where I now work, we follow the concept of "farm to fork" and source ingredients from across India. We use a lot of yogurt—from dips, to marinades and brining. Right now, we make a dip with a yogurt that is allowed to sit outside for a long time so it becomes completely sour. Traditionally, we use earthen pots to make yogurts in India, as they absorb the whey that is released from the milk during the process making it thick like Greek yogurt and imparting a kind of intense flavor of what I call "muddy notes." This kind of traditional flavor is something so unique that I think you'd need a wine connoisseur to explain all those flavors.

Rahul Sharma is sous chef at Masque, a fine dining restaurant in Mumbai driven by indigenous ingredients offered through a seasonal tasting menu. Sharma trained at the Oberoi Group, Marriott International and Leela Palace Hotel.

COUNTING TO 10 IN BEIRUT

TEXT BY ANISSA HELOU

DESIGN BY NATHALIE KHAYAT

(LEBANON / SYRIA)

I recently moved from London to Trapani in Sicily for the sunshine and the beauty of the island and for how close to nature life is, despite it being a city. I only eat what is in season and my milk comes straight from a superior breed of cow, the Cinisara. As I boiled my first batch, memories of how my mother used to make our yogurt came flooding back.

I could see her opening the door to our old milkman carrying two large tin milk cans. I could also see my little self, standing by her, watching the old man dip a tin mug into one of the cans, then pouring the milk into the pot my mother was holding. Once done, she closed the door and I trotted behind her back to the kitchen where she immediately boiled the milk, just like I was doing in my kitchen. After the milk had boiled, she waited until it had cooled enough for her to keep her little finger in it for a count of 10. Only then, could she add the small amount of previously-made yogurt—called *rawbeh* in Arabic—which would start the transformation of the milk. She would place the pot at the back of the white marble counter—most kitchens in Beirut then had marble counters—scoop a little milk out of the pan, whisk it into the *rawbeh*, and gently stir this mixture back into the milk. She placed a clean cloth over the top of the pot and then laid a heavy blanket, to completely cover the pot, on top of that. At this point, she never failed to warn me and my siblings not to touch or move the pan until she told us to. By the time my mother uncovered the pot, the milk had turned into a beautiful white wobbly cake with a thick yellow skin on top.

As I remembered all this, I made a snap decision to make yogurt the way she did. And, lo and behold, the next day I had the same white wobbly cake with the beautiful creamy skin that my mother achieved again and again all those years ago in the Beirut of my childhood. The sight of my first ever home-made yogurt brought back yet more memories, that of my Syrian aunt making butter in Mashta el-Helou in Syria. When her yogurt was ready, she would pour it into a tall, slightly bulbous earthenware jar with a rounded bottom, which she held on a cushion on the floor in between two low stools. She and my mother sat on these stools and took turns shaking the jar back and forth until the time came for my aunt to plunge her hand inside it to lift out a glistening blob of yellow butter. I always hovered around waiting for my aunt to spread some of the fresh butter onto her own home-baked flat bread before slathering a little of her apricot jam over it and handing it to me.

Apricot jam will have to wait till next summer when they are back in season, but my next batch of yogurt is slated to be made into butter, although I will be using my food processor rather than an earthenware jar.

Anissa Helou is a chef, food writer, journalist, broadcaster and consultant focusing on the cuisines and culinary heritage of the Middle East, Mediterranean and North Africa. Anissa is the author of numerous award-winning cookbooks including Levant, Lebanese Cuisine and Sweet Middle East.

Nathalie Khayat is a ceramic artist from Lebanon, currently living between Beirut and New York. Her work celebrates daily rituals and revisits functional objects while exploring their sculptural dimension. Her vessels become a pretext for a poetic dialogue with the matter.

4 NEXT PAGE: Czechoslovakia: Yogurt Bowls and Spoons pop-out poster designed by OKOLO

FOOD AS A TOOL OF THE AVANT-GARDE

(CZECHOSLOVAKIA)

TEXT BY ADAM ŠTĚCH

DESIGN BY OKOLO

The founding of the First Republic of the Czechoslovak state ushered in a golden age of Czech culture, science, technology and economics. Established at the end of the first World War and disappearing with the arrival of German troops in 1939, this era heralded Czechoslovakia as one of the strongest economies in the world with enormous industrial potential as evidenced by the ability to engineer and manufacture everything from world-renowned automobiles and airplanes to light consumer industries like food processing.

The democratic economic environment of the First Republic gave birth to a newly emancipated society, interested in every aspect of modern life. During the 1920's and 1930's, topics like how to live a healthy lifestyle, housing quality, culture and dining were part of everyday conversation. As with the Bauhaus school, the Czech avant-garde believed a hygienic environment coupled with efficient and practical products acces-sible to all could contribute to the project of creating a new modern man.

Ideas around modernity also extended to a new culture of food and dining. Product designers who were engaged with creating new forms for everyday objects — redefining their place in a modern home —explored new visions for food and eating rituals. They refused 19th century clichés of the old-fashioned bourgeois society. New lifestyles and industrial experimentation gave rise to new types of food, bringing us to the glory of Prague yogurt.

Radlická Creamery patented a fruit yogurt in 1933 as an innovation to prevent the spread of unwanted molds. Utilizing new technologies, the company prolonged the shelf life of yogurt by adding a layer of fruit preserves on top. The following year it was introduced to market under the name JOVO, first with strawberry and then with apricot jam. Licenses were then sold to 120 dairies in Czechoslovakia alone and across 15 countries in Europe. By 1934, the mandatory pasteurization of milk was introduced, solving for the original problem of unwanted mold. With the practical issue of food preservation addressed and a market for fruit yogurt established, JOVO stopped manufacturing the fruit layer on top of the yogurt and introduced "fruit on the bottom"-style yogurt as an aesthetic choice. Fruit yogurt was a great achievement of the modern dairy industry and was seen as a sort of delicacy of the future, compatible with a modernist way of life. This modernist ideal was stimulated by the emergence of modern lifestyle products that included food-stuffs, in particular in dairy and confection. Fruit yogurt was just one of many innovative products, edible and inedible, which the dairy industry brought to the dining table. Kofila, the popular coffee-flavored chocolate bar launched by the legendary Orion dairy in 1923, was sold in modern, exotic packaging designed by commercial artist and surrealist painter Zdeněk Rykr.

Radical Functionalists and their program "to create a new man and new society" included design to encourage good nutrition and eating habits. Most notably were the designs from the product and graphic designer Ladislav Sutnar, a pioneer of infor-mation architecture. His porcelain and glass tableware for the retailer Krásná Jizba (Beautiful Room) rejected the traditional vocabulary of luxury mainly associated with richly decorated porcelain services and upheld minimal and efficient design. His interest in food is also documented by his graphic design for the 1937 modernist cookbook, *How and What to Feed: Proper Nutrition Today*, by the Czech ethnographer and food writer Marie Úlehlová-Tilschová.

Other influential designers were interested in products for dining. Ludvika Smrčková created a number of collections in glass and her breakfast service for Antonin Rückl and Sons glassworks is one of the purest examples of Czech Applied Arts. Bohumil Južnič highlighted his talent in a series of metal objects intended for both desk and dining table. His constructivist-shaped bowl for jam, produced by Sandrik, introduced modernist architecture into Czechoslovak households and remains an ode to the ideals of the day.

The consumption and culture around food has always been a rich topic for designers. So it was in Czechoslovakia when new eating habits and food experiences became a vehicle for realizing the utopian dreams of the interwar avant-garde.

Adam Štěch is an art theoretician, writer and curator engaged in design, architecture, fashion. He co-founded the creative collective OKOLO which has produced dozens of publications and exhibitions in the Czech Republic and abroad. Štěch is also the author of numerous texts on design and architecture for local and international press and is an editor of the Prague-based magazine Dolce Vita.

QUARK FOR BREAKFAST

TEXT BY MASON LINDAHL

(RUSSIA)

DESIGN BY LERA MOISEEVA

Through the restaurant [El Rey], Lera and I have developed a friendship. It's a little community here on the Lower East Side so when she expressed interest in sharing a yogurt recipe that she grew up eating, I was like, "Yeah, no problem."

In the United States we call it farmer's cheese—it's not really yogurt but a cultured milk product that is similar to ricotta. The difference is that you're not using a high acid product like vinegar to break the milk and separate the curd, you're using buttermilk. You take milk and bring it up to 100 degrees to activate it and then you add buttermilk. Buttermilk is a cultured milk by product. There's living bacteria in there so you heat the milk to a point where you're inoculating it and not killing off the bacteria —you're allowing it to do its thing.

It's a three-day process—you let the milk sit overnight then bring it up again to ensure the bacteria is activated. You do this again for three more nights and days. It sounds dangerous because the bacteria is living and because you've activated it, there's a larger population of good probiotic bacteria in there that will stop the milk from spoiling. It's essentially what you do with cheese—you're preserving the milk.

As with any cheese, you're separating the curd from the whey so you strain it to separate the liquid which is also part of the preservation process. The moment you take the moisture out of food, there less probability for spoilage.

One thing to note is that in Russia, they eat quark in the morning for breakfast by adding milk and fresh fruits or jam. Farmers cheese, on the other hand, is usually eaten as a savory dish spread on toast or with vegetables.

Mason Lindahl is the head chef at El Rey in New York City. His work on cookbooks can be seen in the Beetlebung Farm Cookbook *and a forthcoming cookbook by The New York Times' columnist David Tanis.*

Lera Moiseeva is a designer from Russia, currently based in New York City. Her design aesthetics are influenced by images of the space industry.

4 NEXT PAGE: Yogurt vessel inspired by The Holy Monastery, designed by Greece is for Lovers. Produced by Nodus.

FROM THE DIVINE HAND

TEXT BY DANAE TSEKOURA (GREECE)

DESIGN BY GREECE IS FOR LOVERS

5 FOLLOWING SPREAD
Jordan: 3D-printed Jameed Press by Hashem Joucka

Like every story, this story starts with a seed.

About 80% of Greek heirloom seeds have become extinct so to fulfill my dream of populating a little plot of land with real food, I was on the hunt for real seeds. By divine hand I was led to The Holy Monastery of St. John the Forerunner in Anatoli. The monastery was founded by the Holy Martyr Damianos in the 16th century and revived by a group of female monastics in 2000. Although the monastery is Greek Orthodox, the 22 nuns that reside there are from all over the world. The countries represented by flag at the entrance of the building are of Russia, Japan, Estonia, Cyprus, United States, Lebanon, Finland, England and Germany.

The monastery is located on the mountain Kissavos (Ossa) at an altitude of 1080 meters. The ride was long and winding but the reward was bountiful. Inspired by each of their country's culinary traditions, the nuns make vegetable and fruit chutney, kefir and cheeses, not to mention potions and lotions, from the wild herbs they gather on the mountain. They are most proud of their beehives and the heirloom seed gardens. The nuns see their gardens as seed banks and they give seeds to anyone that asks.

The nuns also raise animals; companions and friends with names often derived from ancient Greek mythology — there's a lamb called Calliope and a sheep called Kallysto. Amongst all the female cows there's a single male bull and Tony (the bull) is particularly beloved. Tony keeps the cows happy and happy cows make happy yogurt.

We have all heard of Greek yogurt but very few people, even Greeks, have actually tasted the real thing. Greek yogurt has become a sort of brand but what makes Greek yogurt unique? To begin with, it is the milk.

Unlike most yogurt, the Greek yogurt from The Holy Monastery doesn't travel. The cows are milked and the yogurt is made on the spot. From where I stood, I could see the animals grazing on wild herbs that grow on the mountain—oregano, thyme and marjoram. The water on the mountain is also considered one of the best sources of water in Europe—it's actually gotten an official EU rating! At The Holy Monastery, the distance from farm to table had never been so immediate for me. When asked about the secret to the most delicious yogurt in the world, Mother Superior Theodekti's answer is simple: They treat the animals with love and respect, ensuring the animals' happiness.

On a more practical level, the nuns use a natural organic vegetable rennet and their own yogurt starter. They also employ a very old method of slow pasteurization — maintaining the temperature at 65 degrees and then cooling the walls of the pot slowly to keep all of the flavors from evaporating. Another great secret is that the nuns strain the yogurt in the *tsantila*, a shepherd's cheesecloth, for one day and one night until the *tyrogalo* (buttermilk) drips slowly. Despite available technologies, to this day only the divine hands of nuns guide the yogurt making process at The Holy Monastery of St. John the Forerunner.

Danae Tsekoura is the founder of Troo Food Liberation, a food collective in Athens, Greece.

Greece is for Lovers is the design studio of Thanos Karampatsos and Christina Kotsilelou. Their designs narrate an alternative home country and comment on ritual.

DESIGNING JAMEED

TEXT BY LAILA GOHAR

DESIGN BY

HASHEM JOUCKA (TURKEY / JORDAN)

When I was younger, my dad made yogurt at home. It was just a normal thing where he would put the oven on for awhile, turn it off, and then leave the ramekins full of yogurt in there overnight. My mother is Turkish and in Turkish cuisine, yogurt is basically like a food group in itself — there are a lot of savory uses for it and it's very common to use yogurt as a condiment. You'll have stewed green beans, pilaf or bulgur rice, maybe a little piece of meat and some yogurt.

Turkish cuisine is divided in all of these interesting ways and there are restaurants that are dedicated to each style of cooking. When you think about where to eat out in Turkey, the restaurant categories have to do both with ingredient — like meat or fish or vegetables — and preparation. For example, there's a way of cooking stewed vegetables with a little bit of tomato and olive oil. There's a category of "comfort food" restaurants. And then there's cafeteria style places that serve a lot of these olive-oil based food. With all of this there's always yogurt as a condiment or base for a dish. There's also seasonal yogurt dishes like a cold yogurt soup that you'll always find on the summer table. It has cucumber — kind of like a tzatziki but more watery — and people put ice cubes in it.

In some of the neighboring countries there's a really unique kind of yogurt called jameed—a salted and dehydrated yogurt that is dried in the sun. My most memorable experience of jameed was when a friend of mine invited me over because her mother was visiting from Jordan and was cooking mansaf, a traditional Bedouin lamb stew that is the national dish of Jordan. It has almonds and it's served over rice with a sauce that's a mixture of lamb broth and the jameed. The jameed is sold as little balls that are chalky in texture with the consistency of cement that you mix with a tiny bit of water. Because Bedouins are nomadic desert people, their recipes include livestock and preserved and dried ingredients that can keep and store easily. When my friend's mom was making this dish, she brought the jameed out and showed it to me. I have had mansaf a couple of times before, but I had never really thought about the jameed itself. Traditionally you think yogurt has a semi-solid consistency but the jameed is totally different—like with anything that's sun-dried or dehydrated, the flavors are very concentrated.

When I encounter an ingredient like this, I experiment with it on a very personal level. I'll ask myself what the flavor tastes like, what it feels like. I started thinking about different ways to incorporate it in the events that I do. Jameed is so salty and creamy it could be used in place of bottarga. You could shave it or melt it, break it up and re-hydrate it. But then, I always think about the interactions in kinds of food — if there's something that requires people to mix this and that, something that engages people and takes them a little bit out of their comfort zone while injecting some humor.

Laila Gohar uses food as an artistic medium and a tool for communication. Her studio creates multi-sensory food installations in non-traditional environments.

Hashem Joucka is a construction technologist, researcher and maker based in Amman, Jordan. Joucka uses digital fabrication, physical programming and smart materials to create functional art and aesthetic technology.

CULTURING YOGURT

EAT SHIT

WHAT IS THE ULTIMATE FOOD NON-FOOD? SHIT.

WITHOUT FOOD, THERE'S NO SHIT. AND WITHOUT SHIT, THERE'S NO FOOD.

Everybody eats, everybody shits. This subject is linked to so many issues from science, bacteria and medical insights to ideas of self. It's linked to rituals, taboos, culture and society.

In 2015 we had just started the Food Non Food department at Design Academy Eindhoven and I was invited to curate the annual exhibition for the Design Academy during Milan's design week. A lot of people both inside and outside of the design world still think that food design is about shaping food or about attractive, nice styling. For me, Food Non Food is about dealing with so many different issues beyond the shape or representation of food. I decided that if I wanted to present the new

RIGHT
Exhibition view of "Eat Shit" featuring Oliver van Herpt's 3D Ceramics Printer and Jason Page's timeline of 400 DAE graduation projects since 1976 that have focused on food or feces.

TOP
Visitors experiencing Mickaël Wiesengrün's *Grasping Smell*

TEXT BY
MARIJE VOGELZANG

department it needed to be in a larger context. I also liked talking about a taboo and very ugly and smelly subject in the context of Milan where everything is about beautiful, shiny objects.

If you wandered into the space and were confronted with this challenging title, *Eat Shit*, you wouldn't have a clue what we were exhibiting. We created a mindmap to show how the subjects related to shit are serious issues and can both be the problem and solution. We also had a timeline of graduation works beginning from 1976 that dealt with food to show how the subject has always been part of the DNA of the Academy.

There was the hilarious aspect of the show where we had students in jumpsuits with turd-shaped backpacks cycling through Milan. One of the reasons why it's not only important to think about shit, but all our bodily waste, is because we will run out of phosphate in the future. Without phosphate, we cannot produce food. Both serious as well as more humorous approaches can be found in the same topic. Shit is a very rich ground to start from.

The subject also became a jumping-off point for research. For example, one student was interested in understanding how your gut bacteria influences your feelings

so she started to eat bread exclusively to experiment with her own gut bacteria. Then we invited a scientist in to explain what she was actually doing. Afterwards, she baked bread in the shape of the intestines as a conversation starter to spread the word about the importance of gut bacteria.

Another student explored questions around waste in general. In Milan he washed people's feet and collected the dirt. For him, he really didn't know what he was going to do with the dirt but it was a tool to get his thoughts together. When he went back to the Academy, he took all the experience he gained in Milan and made a wonderful project about the value of waste. He collected the dust that he found on the floor and started to make hundreds of little gray crayons. Then people were encouraged to pick up a crayon and start drawing on the wall. It's funny because when you decide what you want to do with dirt, then it's not dirt anymore. It's a very poetic approach that is not answering any questions but I really like the philosophical thinking of how we pose ourselves against the things that we find in our environment.

In the end, the exhibition was very challenging, very different. One student relocated to Dar es Salaam where he's still working on shit—an internship with an artist / entrepreneur who is working on biowaste. Some people really started to understand the value of designers working with food and were very intrigued by us trying to take on bigger aspects of design rather than only making nice things. Other people were quite appalled. Sometimes, people need some time to reflect on things and to chew on it. Food and design is a serious subject and a subject with huge potential—food is the most important material in the world.

LEFT Oliver van Herpt's *3D Printed Ceramics* is a technological innovation that extrudes clay to create tableware and vessels.
TOP Pim van Baarsen's *Holy Crap*, implements a new business model for recycling in Kathmandu, Nepal.
RIGHT Arne Hendriks' *Pigeon Fertilizing Tower*, proposes a guano farm built out of recycled newspaper bricks to house pigeons.

TOILET TECHNOLOGY FROM THE LAND OF

PRODUCTS:

PHOTOGRAPHY
BY THOMAS MCCARTY

TEXT
BY LINYEE YUAN

TOTO

TOTO:
TOILET TECHNOLOGY

Inside a non-descript building an hour outside of Tokyo, the employees of the world's largest toilet manufacturer strap into an empathy suit.

This exoskeleton, constructed of engineered medical braces which add weight to joints and constrict one's range of motion, mimics the physical struggles of elderly consumers. Frosted glass lenses are donned to simulate vision impairment in an elaborate exercise for design research. Established in 2002, TOTO's Universal Design Research Center for Advanced Science and Technology (UD Center), is a monument to decades of research-driven product development and the only facility of its kind. Here, the future of our most intimate products is being written.

TOTO's mission of "contributing to the improvement of people's lives and the development of society in the spirit of social service," was clearly defined by its founder, Kazuchika Okura. In 1912, inspired by the flush toilets he encountered in his travels abroad, Okura returned to his native Japan to set up a laboratory to design sanitary ceramics. Since then, TOTO introduced Western-style flush toilets to post-war Japan, invented the now iconic Washlet (an electronic bidet),

The TOTO Neorest AC includes an integrated UV light and a special glaze developed in TOTO's nanotechnology lab.

and defined itself as a pioneer of universal design. Now in its centennial year, the company looks towards the future by drawing on the philosophy of innovation and service put forth by its founder.

GREEN + CLEAN

TOTO first made a name for itself outside of Japan in the 1980's with the introduction of the Washlet, primarily beloved for its ability to clean with a stream of warm water but marveled for all the other bells and whistles that come with an electronic toilet—white noise, heated seats, automatic open and close cover, air deodorizer, night light and dryer. Today, the brand has become synonymous with technologically-enhanced toilets—over 40 million TOTO Washlets have been sold worldwide and 76% of Japanese homes have installed electronic bidet seats. When weighed against the fact that Americans, on average, use about 50 pounds of toilet paper per person a year compared to Japan's 30 pounds, the environmental savings are significant.

Since the advent of the Washlet, TOTO has continued to lead in sustainability with the introduction of highly effective low-flow toilets, self-generating hydropowered faucets and valves and high-efficiency showers. Twenty years ago, most toilets in the United States used over 3.5 gallons-per-flush (GPF). Today, in a feat of engineering and industrial design, the company's Tornado flushing system has reduced that water usage to less than a gallon per flush while maintaining the familiar form of traditional toilets. The Tornado is a complete redesign of the mechanics of the flush—a rimless design utilizes a seamless, concave shape to design the flow of water around the bowl—two nozzles channel water into the bowl effectively cleaning it as the waste is removed. At the world's largest toilet manufacturer, environmental stewardship leads design innovation.

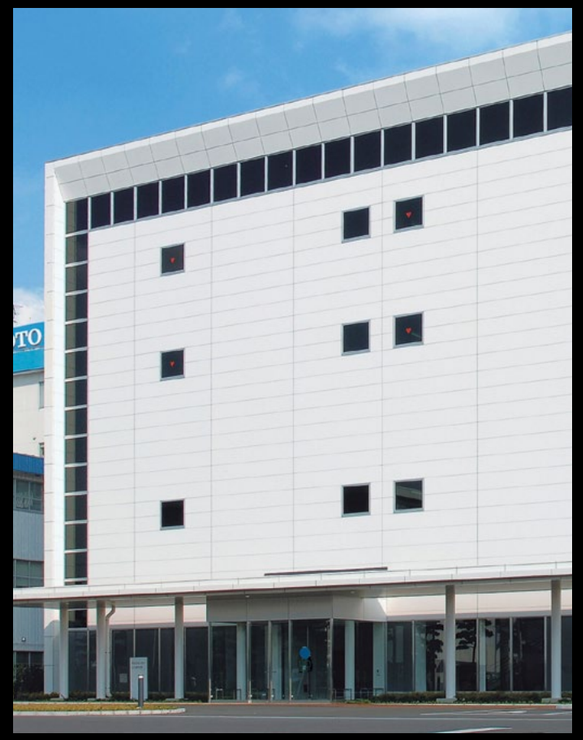
At the TOTO Showroom in New York City, a cross-section of the Neorest reveals the mechanics of toilet innovation.

TOTO'S UNIVERSAL DESIGN

The roots of universal design at TOTO begin in the 1960's when the company received a letter from a customer confined to a wheelchair complaining that their toilets were difficult to use. The designers at TOTO realized they didn't understand this segment of end users so they set off to observe how customers in wheelchairs navigate bathroom products. Soon, a new design that could successfully be used by wheelchair-bound people was introduced and, "as a result, TOTO's product development procedure—in which our designers and developers must completely understand our customers' needs by actually meeting with, talking to and monitoring their use of products during the process of design and development—was established," explained Yasushi Takahashi, General Manager of Product Design at TOTO.

Today, TOTO employs over 1500 research and design engineers to consider the myriad ways that their products can serve consumers. Some of these insights come directly through the UD Center's work in three main categories: development, research and education. A typical day includes testing TOTO prototypes as well as products from competitors during the planning and development stage, analyzing how end users use bathroom products to gain insights, and educational seminars and workshops for TOTO's team of designers where empathy suits and vision-blurring goggles then come into play.

With the inclusion of a broad swath of the population—varying ages, abilities and physical conditions—"one of the most unique features of the



TOP Top A TOTO design researcher monitors a child at the UD Center.
RIGHT Right TOTO's Universal Design Research Center occupies its own building in Chigasaki, Japan.

UD Center is that customers actually participate in the product testing," Takahashi noted. From observation and anthropometric studies, the UD Center's researchers also monitor product users' actual movements in the bath space. Takahashi recounts the importance of observation; in one example an elderly customer denied using handrails during an interview but through observation, the UD researchers noted he used them regularly in the bathroom. "It's rare that people can explain how they move in bathrooms and restrooms. We don't even know how anyone (other than ourselves) utilizes these places... As a result, we think it's important to observe the product with its users and learn the reality of their experience."

This emphasis on experience drives to the heart of TOTO's brand promise of serenity: everyday products should be easy to use for everyone. With feelings of vulnerability, cultural taboos around bodily functions and rituals for cleanliness wrapped up in the four walls of our bathrooms, 'serenity' might seem like a strange guiding principle for a product line best known for its toilets. But by the year 2055, Japan's elderly population is expected to account for over 40% of the population and the majority of these elderly citizens will live alone. TOTO is preparing for this near future by solving for serenity through design research. Innovations like towel bars that are strong enough to be grab bars, sensor-enabled operation of their faucets, and hands-free functions on the Washlet, all came out of TOTO's work in universal design.

WHAT WONDERS MIGHT THE TOTO TOILET OF THE FUTURE HOLD?

Conveniently located next door to the UD Center is TOTO's nanotechnology lab. The building, of equal size to the UD Center, represents the company's deep commitment to materials research and may hold the key to understanding the future of toilet design.

In 1998, TOTO introduced HYDROTECT, a self-cleaning, hydrophilic, anti-bacterial coating used as a glaze for the interior of their toilet bowls. Through a collaboration with the University of Tokyo, TOTO discovered the hydrophilic and photocatalytic properties of titanium dioxide in a zirconium glaze. "At the

Embedded with motion sensors, a choreography of opening and closing TOTO toilet seat covers greets visitors.

molecular level, it's generating a layer of singlet oxygen ions which are basically free radicals," explained Lenora Campos, Senior Public Relations Manager for TOTO USA. For consumers, this means that organic waste like lime scale, mold and waste won't stick to the bowl's coating and a UV light built into the seat lid of models like TOTO's Neorest activates the free radicals. "These free radicals are looking to bind with organic matter, whether that's a virus, bacteria, mold, mildew or waste — anything in the bowl is being destroyed."

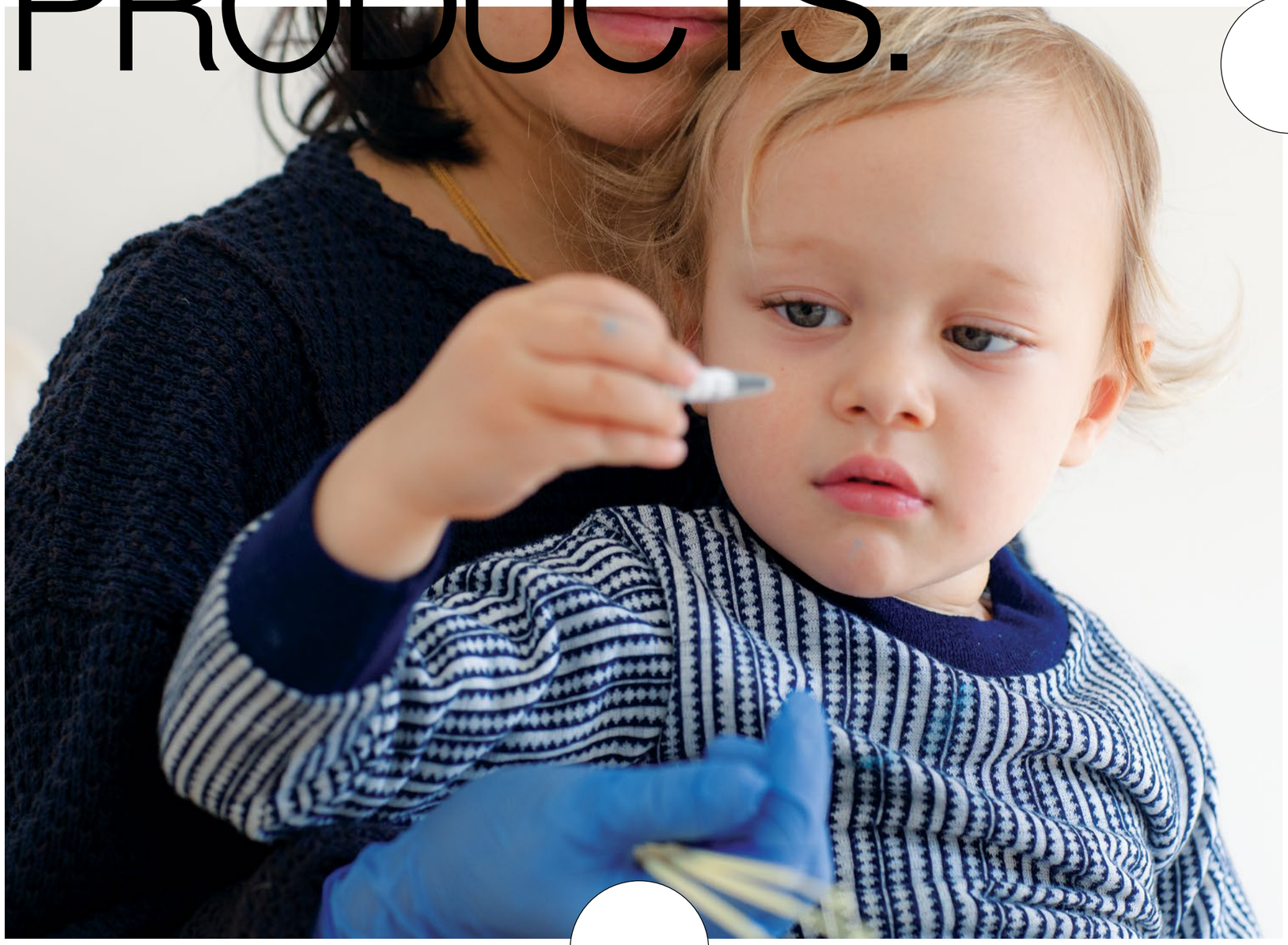
Additionally, certain TOTO models produce electrolyzed water, which has an antibacterial effect, acting like a weak bleach to sanitize the interior of the bowl with each flush. The marriage of design, engineering and material innovation means less harsh cleaning chemicals entering the waste stream, reduced water consumption and less time cleaning the bathroom. As Campos put it, “That’s better for you, that’s better for the environment. It’s better for the planet and it saves you cost and time.”

More recently, TOTO and Daiwa House introduced their Intelligence line, a biometric bathroom with a toilet that can analyze urine, a blood-pressure cuff built into the counter, scales integrated into the flooring and a BMI monitor. The product predates the current connected home craze but the focus on personal health and the underlying technology to record biological data points seems prescient.

Hewing to its century-long pursuit of social service through sanitation, the company continues on its trajectory of innovation at a human scale. “TOTO will be increasing the speed of design evolution in response to water and energy savings, consumer’s health needs, and interior structural changes around the development of products that use network connections,” Takahashi confirmed. “These will arise from existing technology and product design combined with TOTO innovations. As you know, innovation does not descend from the heavens. It arises from new and revolutionary ways of looking at existing technologies and products.”

PRODUCTS:

PHOTOGRAPHY BY
THOMAS McCARTY &
ZACK KREVITT



AMINO LABS

BY EMILIA MORANO-WILLIAMS

If the future lies in the hands of scientists and engineers, where does that leave designers? Designer-entrepreneur Julie Legault believes synthetic biology holds the answer. Legault founded Amino Labs to develop DIY desktop kits to guide people of all ages through the process of genetic engineering. Over the course of several days, DIYers prepare petri dishes and inject cells with DNA to grow bacteria to produce colors, light, flavors and aromas. These can then be extracted and purified into pigments for paints or into scents that can be worn or sprayed. As *Wired* wrote, it's the "Easy-Bake Oven" approach to designing living organisms.

Amino Labs launched in 2015 after participating in MIT's E14 Fund and in San Francisco's IndieBio accelerator. After a successful crowdfunding campaign, the company has developed hardware and "wetware" bundles as a straightforward tool to get people interested in synthetic biology. The Engineer-it Kit supplies the tools needed to engineer bacteria to produce pigments,

Playground

lights or smells. If you don't have access to a lab environment, you can purchase a DNA Playground or All-In-One Bioproduction Lab, desktop hardware that provides the optimal conditions for bioproduction, such as turning E. coli purple. The team hopes the mini-labs can, "show kids that you can have fun with science and that it can be applicable," Legault explains. The Labs are educational tools to get kids excited about bioengineering while teaching their parents about the technology's potential.

Legault's interest in design led her to science, "I was more artsy as a kid [and] I didn't see how art and design could be connected to synthetic biology." While researching ways to create perfumes that react to hormones at MIT, theory-heavy biology courses left her afloat in a sea of abstract concepts. Then, a hands-on synthetic biology tutorial introduced Legault's material-focused design mind to the potentials of manipulating cells. "What was really exciting is that without having a biology background we were able to engineer bacteria over a couple of days. [The class] gave me the confidence to try and find my own work in synthetic biology."

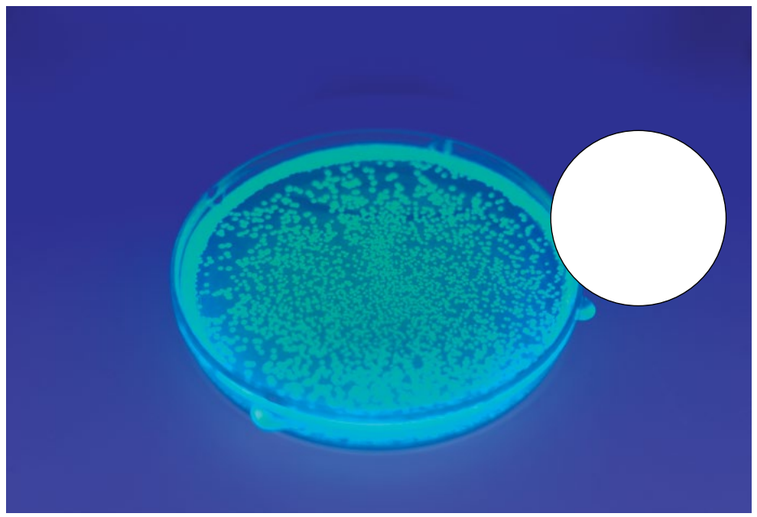
After graduating from MIT's Media Lab, Legault found business partners with backgrounds in science and engineering to continue her education. "I was lucky to find people who were willing to answer my questions but writing the instruction books [for the Amino Labs Kits] helped me learn the science the most." Legault hopes that after following an Amino Labs Kit, users will understand the fundamentals of how synthetic biology works in addition to having some fun manipulating cells.

Although it's easy to impress people with stories of glow-in-the-dark bacteria and engineering cells to emit fruity aromas, synthetic biology remains niche. "For us it's really the nonscientist and the future scientist we're aiming at. We want to broaden the amount of people who have access to the space and give them the hands on experience they need to get started." This will give designers the potential to create new materials, children the ability to grow their own paint colors, and everyone the power to customize their food. While there remains legal and safety hurdles to overcome when using DIY synthetic biology kits in food production, there is the potential to alter baking and brewing yeasts so they have unique and customizable vitamin or flavor profiles.

As with any scientific development, DIY synthetic biology raises a series of questions and ethical problems. Who gets to control engineered cells? Who will have the know-how? How can we predict the outcomes?

"There's good practice and bad practice and we need to be aware of what it means," explains Legault. "But you don't know what [synthetic biology] means until you get that hands on experience." Amino Labs offers a solution through education. The Easy-Bake Oven primed a generation of kids to get crafty in the kitchen. Here's to hoping that Amino Labs prepares the next generation to get smart about synthetic biology.

Special thanks to Avena and Malcolm Gallagher.



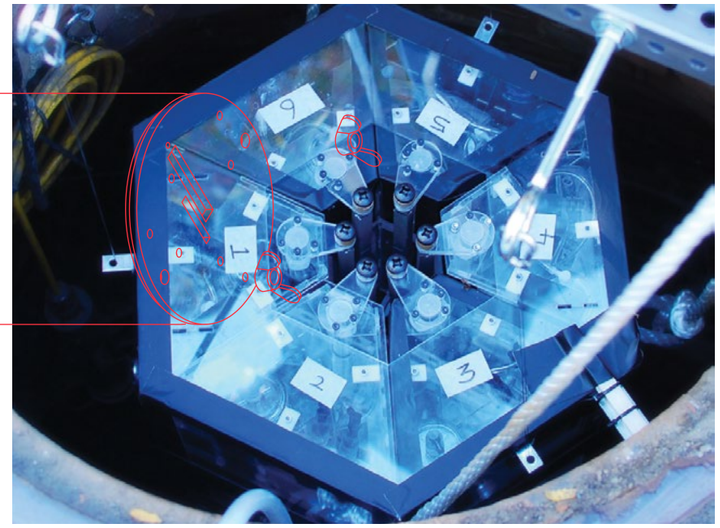
PRODUCTS:

ONE MAN'S SHIT

ANOTHER MAN'S TREASURE

LEFT Axonometric view of Luigi showing the Mechanical, Electrical and Sewage components of the robot.

RIGHT Mario prototype developed by MIT's Senseable City Lab in collaboration with the Alm Lab.



HOW SEWAGE SYSTEMS TELL THE STORY OF SOCIAL NUTRITION

by ADRIANA KRASNIANSKY

When you want to gauge public opinion, you take a poll. When you require a demographic snapshot, you conduct a census. When you need to investigate public health, you look at poop.

Such is the surprising, and surprisingly effective, strategy of MIT professors Carlo Ratti and Eric Alm, who are researching human health through our nation's urban sewer systems. "Why the focus on shit?" you may ask. Until recently, most large-scale studies on human biology have researched public records, tissue, cells, genes or similarly polite data sets, but the scientific community now believes these studies overlook a key component

PSEWAGE MAPPING

of our physiology—microbes. Microbes, the (mostly) single-celled species such as bacteria, fungi and viruses that enter and live within the human body, play key roles in regulating our internal processes, including reproductive and gastrointestinal health. Microbial makeup in the digestive system, in particular, is speculated to influence a breadth of conditions including obesity, diabetes, autism and asthma.

While microbes can be collected and analyzed from swabs of the mouth or genitalia, their most comprehensive snapshots are found in excrement. Ratti and Alm identify cities' sewage systems as "natural aggregators" of microbes; when studied collectively, citywide fecal analyses weave an admittedly shit-stained tapestry of "what is in our collective gut" the two say, offering a clearer picture of social nutrition and, more generally, public health.

In order to assemble their biobank of data, Ratti and Alm recruited a team of scientists, engineers and designers to build Underworlds, a digital platform that analyzes the molecular makeup of sewage shortly after it enters the collection system. Collection time is of the essence, as gut bacteria survives an average of ten minutes after excretion. Until Underworlds, sewage had been studied at treatment facilities, where, due to processing and travel times, samples only contained 15-30% of their original microbes. By collecting samples closer to home toilets, Underworlds harvests a much more active and descriptive sample.

Ratti and Alm's first data collection tools were akin to large pooper scoopers: "Initially, our sampling method was very low-tech; we lowered a 20-foot pole with a bottle taped to the end of it into a manhole and scooped out our sample," says Ratti who leads MIT's Senseable City Lab. The pooper scoopers were replaced by peristaltic pumps, and later, a robot designed to collect sewage. The first poop robot was named Mario, after the *Super Mario Brothers* character and "world's most famous plumber," explains the team; a second generation bot, named LUIGI, beams information such as pH levels, temperature and oxygen concentration while collecting samples for the team.

By cross-referencing urban data with LUIGI's metrics, Underworlds offers detailed insights about a city's health, including routines (mealtimes identified by increases in bile acid), drug dependencies and pathogens. Underworlds visualizes this data on its website for public and academic research—in one Boston sample, Underworlds identified 58,309 microbes, including pathogens that have been linked to cancer development. The team hopes that these biomaps will help public officials monitor contagious diseases, predict outbreaks, and address common deficiencies or unhealthy habits.

Underworlds is expanding its collection program across Boston, Cambridge and Kuwait City, embarking upon a microbial comparison of geographies, climates and cultures. Ratti predicts that once installation and collection protocols are streamlined, participating cities will deploy 10-20 LUIGI robots to continuously monitor different neighborhoods, creating an Internet of Things (IoT) network for each urban sewage system.

IoT excrement analyzers, like any data-collecting technology, raise privacy concerns for a city's anonymous and likely unknowing participants; the ethical argument for sewage analysis also hinges on whether microorganisms are considered part of, or separate from, their hosts' bodies. For many, the ethical concerns of human sewage mapping may be too impolite for discussion. But as microbial data grows to play a larger role in our understanding of health, talking shit may soon become a personal and public priority.

For more insight from the UNDERWORLDS project, see underworlds.mit.edu

MIT Researchers monitor LUIGI as the autonomous robot collects data in the city's sewer.

MIT Researchers lowering the sewage-collecting robot into the city's sewer system.

Senseable City Lab's second generation sewage-collecting robot, LUIGI.

PRODUCT: DIGESTIVE CARS

Could a Cow Stomach Hold The Future of Sustainable Automobiles?

IMAGES COURTESY OF
YIWEN TSENG

TEXT BY

SAM DUNNE

As concern for global warming has grown in recent years, animal agriculture industries and 21st century meat-eating habits have come under increasing scrutiny as major culprits in the modern world's pollution problem – some studies put the measure of animal effluence (and perhaps other associated output) as the source of 50% of all greenhouse gases being released into the atmosphere. It's perhaps then more than just a little surprising to hear that the very same processes governing animal internal organs could hold potential as a future sustainable energy source for mass transportation.

As part of her thesis project for the Royal College of Art in London, product designer YiWen Tseng displayed a wildly speculative concept for a future bio-powered car, with petrol tanks and pistons replaced with the digestive system of a cow.

Tseng's concept explores the possibilities of a distant future in which industrial design and biotechnology blend into one — a world in which the 3D printers of tomorrow churn out complex organs and organisms at ease. Inspired by cattle's impressive ability to transform grass into vast quantities of methane, Tseng's Digestive Car imagines that the digestive tracts of cows could be re-engineered and artificially recreated to produce methane to power an electric vehicle, with only grass as fuel and little by way of exhaust.

In similarity to its bovine origins, the Digestive Car requires four separate 'stomachs' to produce its power–the organs on show in transparent shells to allow motorists to monitor the health of their vehicles 'digestion'. Tseng's speculative designs also imagine that the forms of the organs may also be adapted by bioscientists to optimize for methane production efficiency.

Although clearly still a long way off (and perhaps not that appealing as a consumer vehicle in its current high engine to cockpit form), Tseng's concept is an important reminder of the changes we are likely to see as biotechnology plays an increasingly important role in our every day lives. Not totally spurious, Tseng's research for the project did go as far as intimate exposure with cow innards — meticulously documenting the constituent parts with photography (beautiful and disgusting in equal measures) and denotation of functions.

GEOPHAGIA

ABBYE CHURCHILL

original naturopath and number-one health food store aphorist Hippocrates ("Let food be thy medicine and medicine be thy food.") provides one of the first written testaments to earth eating with this prophetic warning: "If a pregnant woman feels the desire to eat earth or charcoal and then eats them, the child will show signs of these things." Around 500 years later in ancient Rome, scientific writer Pliny recommended alica, a red clay porridge known for its calming properties. And in Byzantine obstetric

LEFT
Wangechi Mutu. *Eat Cake* (detail), 2012. Video installation. Brooklyn Museum, Alfred T. White Fund, 2014.9.©

CONSIDER THE EARTH EATERS

Blame it on Shailene Woodley. Or Salma Hayek for that matter. The two have recently introduced the practice of ingesting clay to a new generation. Ms. Woodley, for her part, recommends brushing your teeth with the powdered grit and swallowing it whole as an inner-outer cleansing treatment. Ms. Hayek's uber-juice bar, Juice Generation, has recently added Pure Earth to its menu—a shot made from alkaline water, rosewater and bentonite clay designed to "detoxify." The concept seems simple: clay is hydrophilic, meaning that it pulls fluid away from its substrate, and with it (in theory) the toxins that are built up in the body. Think of it like giving your inner organs a facial.

But, there may be other positive effects to digging in on the dirty stuff. Some nutritionists advise that eating dirt means you're also eating beneficial soil-based organisms that contain calcium, copper, magnesium and iron. Dr. Josh Axe, author of *Eat Dirt: Why Leaky Gut May be the Root Cause of Your Health Problems* has a fear-not policy on letting a little dirt sneak into your diet: "Today's generation is missing out on vitamin dirt in a big way, thanks to our collective obsession with over-sanitation and antibacterial overkill — like sanitizing hand gels, antibacterial soap and germ-killing wipes." It is a similar philosophy to allowing our bodies to fight off common colds and flus instead of over-prescribing antibiotics: what doesn't kill us will, eventually, make us stronger.

If eating dirt isn't luxe enough, a more rarified example of the brown stuff is slowly making its way westward with shilajit, a resinous excretion found in the mountains of India and Tibet. This black gold is made from plant and organic matter that has been caught and pressurized by the mountains, extruded out of rocky crevices like tar and containing (by some counts) over 85 trace minerals and fulvic acid. Now highly prized for its nutritional value, shilajit is marketed as a superfood and can be purchased in powder, capsule or, as nature intended: as a black, sticky, oozy liquid.

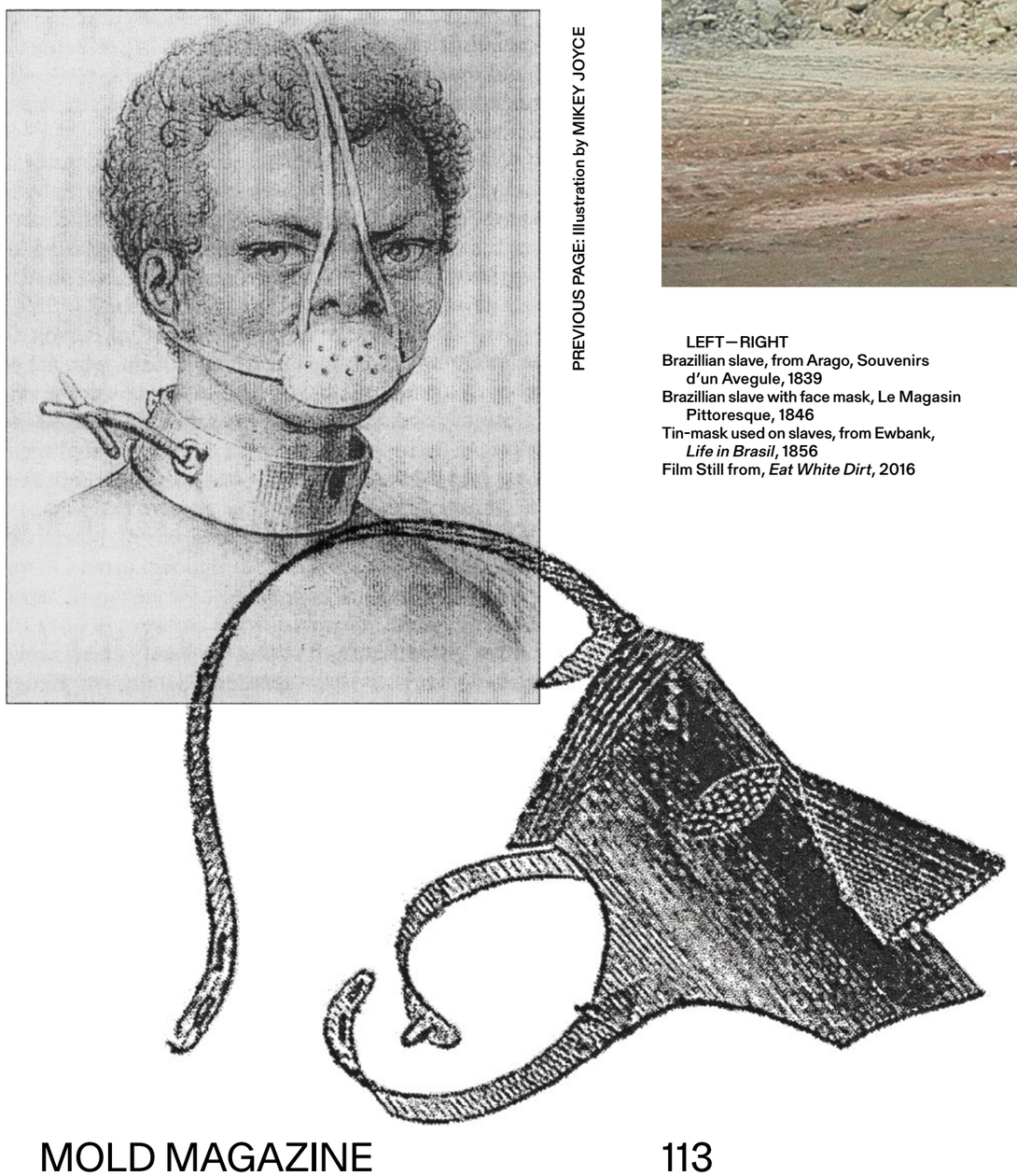
This recent glamorization of clay eating is a very new twist in a long history of what's clinically called geophagia: the practice of eating earth, soil, clay or chalk. Most recent history aside, responses to the practice have historically run from obsessive to ambivalent, pejorative to the poetic. Until the invention of the inner-organ spa treatment, geophagia had been considered a form of pica. Named in honor of a magpie for the bird's indiscriminate attraction to shiny objects, pica is an eating disorder identified by the American Psychiatric Association's *Diagnostic and Statistical Manual* as "persistent eating of nonnutritive substances." Replace notions of potential inner calm purported by contemporary celebrities and some nutritionists with the obsessive determination of a woman on TLC's *My Strange Addiction* who eats a square foot of mattress every day, and we can begin to better understand how far the practice has come in the cultural lexicon.

But before there was Juice Generation, leaky gut syndrome, or reality TV, there was earth. And there was ancient philosophy. The

journals, the consumption of clay is recommended as a curative treatment for pregnant women to satisfy cravings. These ancient philosophers weren't entirely incorrect. What we know today as Kaopectate—the go-to digestive curative—was originally formulated from kaolin, a binding clay, before being replaced by the synthetic chemical bismuth subsalicylate, or as we commonly know it, Pepto-Bismol.

Perception of earth eating shifted again in the 18th and 19th centuries as parts of Africa and the Americas were colonized by European explorers. French emissaries to Brazil observed the slave trade in Rio de Janeiro and saw men and women with tin masks affixed to their faces. In *Consuming the Inedible: Neglected Dimensions of Food Choice*, social anthropologist Jeremy MacClancy explains that mouth masks were placed by slave owners to prevent earth eating which "slaveholders claimed, was practiced by suicidal slaves sunk in misery and wishing to escape punishment." Similar masks were used by British colonists in Trinidad, and designed with the same intention. These masks indicate not only a fear of the practice of earth eating and its potential mortal ramifications, but perhaps point to an insecurity around exacting control over the unknowable.

In our contemporary Western cultural imagination, artistic representations of eating dirt indicate ecstasy or hysteria—a poetic gesture of a person mad with longing, insatiable, desirous. An auspicious indicator of pregnancy in many cultures, the desire to eat dirt appears in Steinbeck's *The Grapes of Wrath* and Gabriel Garcia Marquez's *One Hundred Years of Solitude* as a feverish desire, tethered to some unknowable earthly rhythm. Marquez describes his protagonist Rebeca getting up "...in the middle of the night to eat handfuls of earth in the garden with a suicidal drive, weeping with pain and fury, chewing tender earthworms and chipping her teeth on



PREVIOUS PAGE: Illustration by MIKEY JOYCE

LEFT—RIGHT
Brazillian slave, from Arago, Souvenirs d'un Avegule, 1839
Brazillian slave with face mask, Le Magasin Pittoresque, 1846
Tin-mask used on slaves, from Ewbank, *Life in Brasil*, 1856
Film Still from, *Eat White Dirt*, 2016

snail shells." The scene calls to mind, decades later, Kenyan artist Wangechi Mutu's 2012 video piece "Eat Cake." In the piece, the artist sits crouched by a river, ravenously devouring a chocolate cake. Her ritualistic swaying appears primal and in stark contrast to her translucent heels and contemporary dress—an ornament designed to separate person from behavior, woman from nature.

Today, we see examples of geophagy practiced around the world, but not without external stigma. In the Southern United States, in particular central Georgia where clay is plentiful, kaolin or "white dirt" can be commonly found at farmers markets, as well as backyards. Sam's White Dirt of Georgia offers online "discreet" shipping outside of Georgia—perhaps a nod to certain ambivalent receptions of the practice. And headlines in the United States recently blared that in impoverished areas of Haiti, where the average person lives on $2 a day, locals make cookies out of dried yellow clay, vegetable shortening and salt to survive. A different image entirely from the pristine 1-ounce rose-flavored shot of Pure Earth sold a few hundred miles to the north.

Today, perhaps as always, our perception of earth eating lies somewhere in the balance of natural desire and cultural conditioning, global perspective and socio-economic strata. Contemporary Western nutritionists posit that soil could be our next "future food" as a source of abundantly available minerals. Conversely, in the hands of celebrity endorsements and well-lit juice bars, a shot of clay connotes the promise of a purified, cleansed life unbound by the shackles of toxic urban centers. A bar of kaolin discreetly bought online for consumption tells a different story, a story that Marquez's Rebeca knew intimately. "Whoever had raised her had scolded her for that habit because she did it secretively and with a feeling of guilt." Implacable, she tried to console herself, "in the taste of earth."

HARNESSING THE MIND-ALTERING POWER OF MICROBES

BY DANI LEE

ARTWORK
BY MIKEY JOYCE

RECENT SCIENCE IS UNLOCKING THE POTENTIAL MECHANISMS FOR THE AGE-OLD LORE OF 'GUT FEELINGS' AND IT MAY HAVE TO DO WITH MICRO-ORGANISMS LIVING INSIDE OUR INTESTINES.

For centuries, medicinal traditions including Traditional Chinese Medicine and Ayurveda have touted the connection between our gut, brain and overall health. Now science is proving that our guts have a mind of their own and it's in the shape of a thriving microbial ecosystem.

We are quite literally covered and filled with trillions of microscopic organisms that outnumber human cells 10 to 1—bacteria, viruses, protozoa, archaea and fungi—most of which inhabit our digestive tract. The science is just emerging, but research is showing how imbalances in gut microbiota may play a role in a range of medical disorders including diabetes, obesity, irritable bowel syndrome, Parkinson's, autism, anxiety and depression.

HOW MICROBES TALK TO OUR BRAIN

Complex microbial and physiological mechanisms involving the nervous, endocrine and immune system mediate communication between gut microbes and the brain. We are only beginning to understand this relationship, but based on studies in animals and humans, we do know that gut ecology may influence mood, immunity and even social and physical behaviors.

Take for example the vagus nerve, the longest of twelve cranial nerves, which connects the brain and spinal cord to the 500 million nerves along the intestinal tract starting from the mouth all the way to the anus. Information travels bi-directionally between the brain and gut via the vagus nerve, but mostly from gut to brain. Studies show that when the vagus nerve is severed, gut-to-brain communication is altered.

Certain gut microbiota synthesize neurotransmitters like dopamine and serotonin, which are involved in reward-based behavior such as eating and sex and also regulate mood and sleep. In fact, 90% of serotonin and 50% of dopamine in the

body is found in the intestines. Another example is microbial-produced L-DOPA, which can cross the blood-brain barrier where it is converted into dopamine and ultimately norepinephrine, a chemical messenger that influences physical movements, social behavior and emotion in humans.

HACKING OUR GUT MICROBIOTA: BENEFICIAL MICROBES FOR OPTIMAL BRAIN FUNCTION

In the recent best seller, *I Contain Multitudes*, author Ed Yong points out that for every gram of food we eat, we swallow a million microbes more. Given the increasingly evident role microbes play in influencing our health and possibly our psychology, what ways can we redesign our food supply to ensure that the microbial diversity in our guts is nurtured?

PREBIOTICS AND PROBIOTICS TAILORED TO ENTEROTYPE

Each human has their own unique gut ecology, known as an enterotype. There are three human enterotypes classified by the predominant gut bacterial species — *Bacteroides*, *Prevotella* and *Ruminococcus*. This thriving ecosystem is influenced primarily by our diet as well as environmental exposures to toxins, antibiotics, stress levels and other factors like whether a person is birthed vaginally or via cesarean birth.

Studies suggest that consuming a combination of pre- and probiotics can affect gut ecology and mental health. Gut bacteria convert prebiotics — the indigestible components of plant foods and certain sugars in human breast milk — into a variety of metabolites which are used as fuel for our intestinal cells and influence the immune system cells in our gut. In a 2014 study, healthy volunteers fed prebiotics had lower stress hormone levels and were more likely to pay attention to positive stimuli than negative stimuli during a test of emotional reactivity.

Ted Dinan, professor of psychiatry at the University College Cork in Ireland, coined the term 'psychobiotic' in 2013, describing it as a new class of probiotics that, when ingested in large enough amounts, will produce a health benefit in patients suffering from psychiatric illness. A 2011 study published in the *British Journal of Nutrition* suggested that a 30-day course of probiotic bacteria supplements resulted in decreased anxiety and depression in healthy human study participants.

It should be no surprise that biotech, supplement and food industries are capitalizing on the good gut microbiota hype —it is estimated that the global probiotic marketplace will be valued at $46.5 billion by 2020. Beyond supplements and yogurt, probiotics are being added to hundreds of new engineered food products including chocolate, granola, snack bars, powdered beverages, juices and more. With the

increased capacity for individuals to know their own enterotype through services like my.microbes.eu and the American Gut Project, companies could start engineering customized pre- and probiotics.

DESIGNING FOOD PRODUCTS

Expanding the diversity of pre- and probiotics incorporated into engineered foods may be a solution, but will this be as effective as nature's probiotics? Studies of infant formulas containing pre- and probiotics are continuously shown to be not as effective as nature's perfect food for developing infants—human breast milk—which contains its own pre- and probiotics. Consumers should consider this when contemplating adult versions of formula products like Soylent and other meal replacement powders.

Nature is a great engineer of probiotics through fermentation, and humans have a long relationship with fermented foods. Neolithic vessels used for fermenting rice, fruit or honey beverages date back to 10,000 years ago. In their 2015 book, *The Good Gut*, husband and wife Justin and Erica Sonnenberg, researchers at Stanford University, suggest that when compared to engineered probiotics in food and supplements, fermented foods contain a larger diversity of bacteria and provide an increased chance of exposure to a beneficial bacteria that might better suit an individual's unique gut environment.

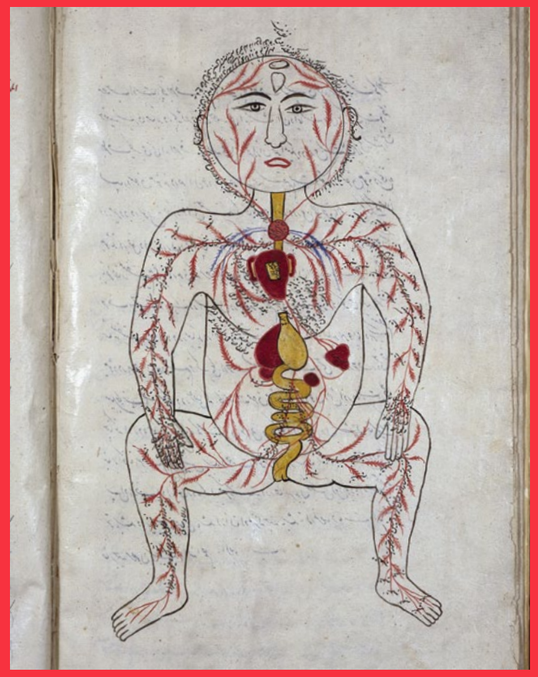
And the research supports this. In 2012 researchers found that a particular strain of *Lactobacillus* isolated from Chinese cabbage kimchi reduced memory deficit in mice. A 2015 study of 710 young adults who self-reported eating fermented foods also reported having fewer symptoms of social anxiety.

A DIET TO FEED BENEFICIAL GUT MICROBIOTA

Beyond the microbes in supplements and fermented food, components of food itself may play a role in influencing psychology by changing our internal microbial environment. Studies show that individuals consuming Western diets high in processed foods, unhealthy fats, added sugar and salt, and low in plant fiber have markedly different, less diverse gut microbiota compared to individuals who follow a more whole-foods, plant-rich diet.

Two recent books make the argument for a diet-based approach to address psychological disorders. Dr. Natasha Campbell-McPride's 2004 book *Gut and Psychological Syndrome* proposes the GaPS diet of fermented foods, vegetables, fruits and meat, and encourages her patients to eliminate processed foods, sugar, starches from grains and potatoes, soft drinks, soy products, alcohol, unfermented dairy products, beans and coffee. Although Campbell-McPride has many case studies showing efficacy in some of her patients, no controlled human studies testing the effectiveness of this approach have been conducted.

In The *Mind-Gut Connection*, Dr. Emeran Mayer proposes a mostly plant-based Mediterranean diet rich in fermented foods, vegetables, fruits, legumes, nuts and seeds, fish, whole grains, healthy oils and moderate in animal proteins to support gut and psychological health. The Mediterranean diet is already associated with improved blood cholesterol levels, and reduced incidence of cancer, Parkinson's and Alzheimer's disease.



Human body, arteries and viscera, Persian, 1893

SHIFTING AGRICULTURAL PRODUCTION

But do we have access to the right food to support optimal gut health? Over 75% of Americans aren't eating enough fruits and vegetables and our current domestic food supply does not adequately provide enough fruits, vegetables and whole grains to feed each American the recommended amount — one cup of whole fruits, two cups of vegetables, and three ounces of whole grains each day—for optimal gut health. The National Cancer Institute reports domestic fruit and vegetable supply would need to increase by nearly 50% to support federal recommendations for fruit and vegetable intake.

How we produce our food can impact our gut microbiota. Intensive livestock production contributes to residual antibiotics found not only in our meat and dairy, but also in the soils and waterways used to grow plant foods. With the livestock industry utilizing 70% of antibiotics produced in the United States, how might antibiotics be influencing our individual microbiomes? In 2013 Dr. Lee Riley of UC Berkeley authored an article exploring how increased use of antibiotics in our food supply could be responsible for increased prevalence of obesity by altering gut microbiota. Is it possible that antibiotics in our food may be contributing to psychological disorders as well?

BETTER FOOD, BETTER MOOD

We are more microbes than human, and with the emerging science of how diet influences gut ecology and the increasingly strong link between gut ecology and psychology, consumers can do themselves and their brains a favor by nurturing their inner microbial ecosystems. Designers have a role to play in improving our food systems by translating the science into delightful and compelling solutions that ensure access to beneficial foods produced in more efficient agricultural systems that support optimal gut health.

TEXT BY PETER McCOY

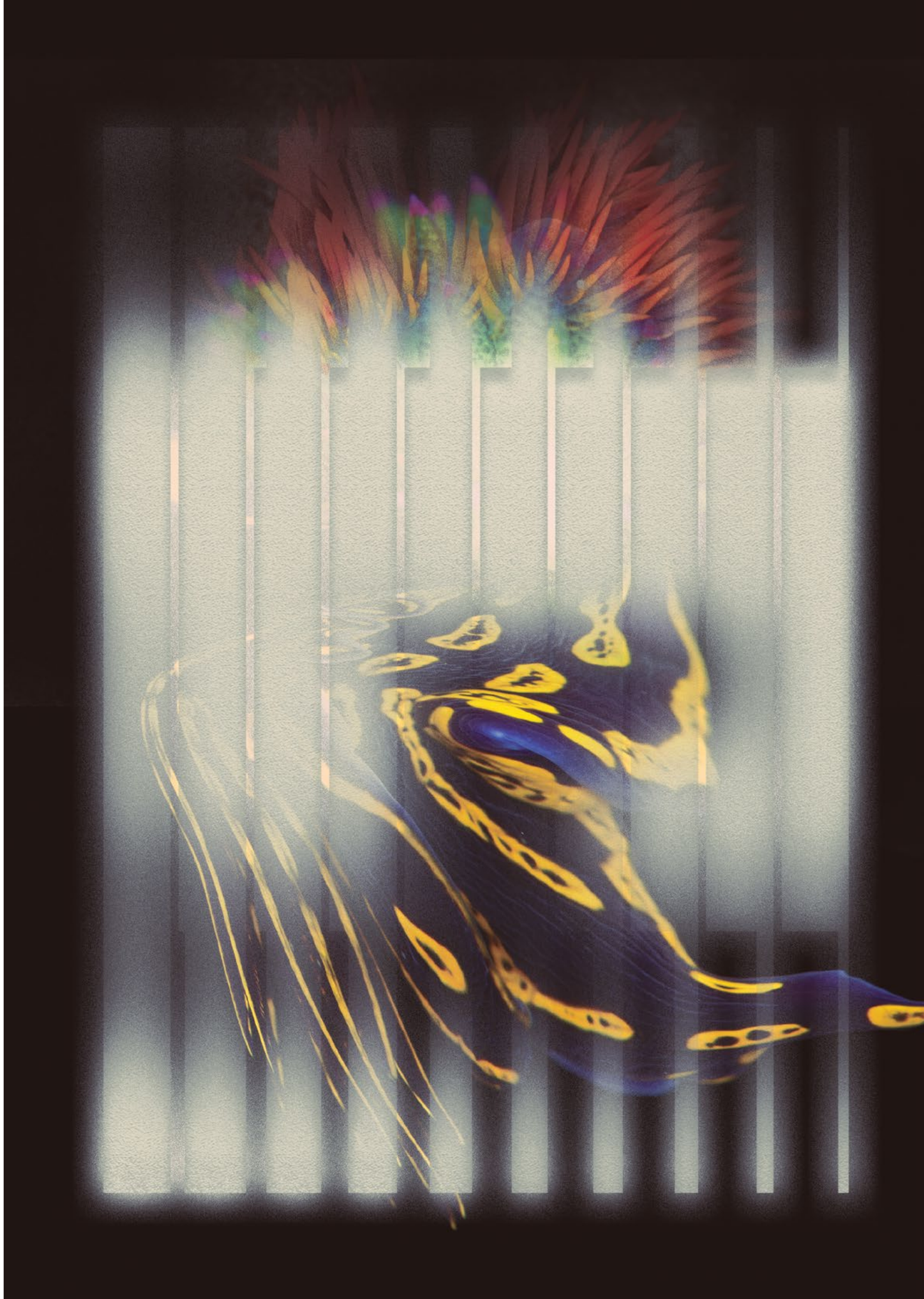
ART BY ERIC HU

The Next Great Revolution in Wellness Might be Fungal

Consumption of mushrooms by humans is an ancient practice dating back at least 18,700 years to the Paleolithic "Red Lady" of Spain. Reaching even further back in history, one will find the role of fungi in making mead, the first food products intentionally crafted by humans—simple honey wines made by fungal yeasts. Fungi continue to occupy an ever-expanding role in the culinary and medicinal landscape. Leveraging complex ecosystems, fungi act as nature's greatest stewards and healers—powerful and ancient allies with whom modern humans have only begun to recognize as critical to sustaining all life.

To the elites of ancient Egypt and Greece, mushrooms and truffles were considered *broma theon*, "foods of the gods," so revered was their potent flavor and nourishing effect. In the East, mushrooms were central to the health and longevity of the Taoist immortals; in Traditional Chinese Medicine's (TCM) foundational texts written millennia ago, the Reishi mushroom is recognized as the "king of all herbal medicines." Above Ginseng root, Reishi is seen as the most potent of all stress-reducing and balancing medicines (adaptogens) in TCM. Carved into the entrance to the Forbidden City in Beijing and woven into the robes of emperors, this mushroom's form stood as a symbol to the ancient Chinese of vast power and enduring strength.

Along with mushrooms, various molds and yeasts have long been appreciated for their nourishing qualities. Molds are celebrated for their ability to enhance the flavor and nutritional value of plant matter, an appreciation found in many traditional fungal-



dominant ferments. For generations, *Aspergillus sojae* has been grown on barley and rice to create *koji*, a moldy grain product used in the production of saké and the umami-rich condiments of miso, soy sauce and tamari. Similarly, producers of wine—itself a product of yeast—often spray grapes with the mold *Botrytis cinerea* to produce the "noble rot" that concentrates the fruit's flavor, thereby creating the rich flavors of botrysized dessert wines. The alternative meat product tempeh is likewise created by growing *Rhizopus oligosporus* on grains or legumes over the course of a single day. During this time, the mold ferments the ingredients to enhance their flavor and nutritional value while also knitting them together into a protein-rich patty.

In all of these moldy foods, the fermentation is performed by the fungus' primary tissue known as mycelium. Mycelium is what comprises the bulk of most fungi—it's the white, web-like stuff commonly found beneath old logs in a forest—it's the same tissue that lies beneath the colorful spores of molds and also the tissue that is condensed into the macroscopic structures we call mushrooms.

In all environments, mycelium critically influences the nutrient access and overall health of plants and animals. Fungal mycelium can readily digest complex animal and plant matter into simple sugars and proteins, while simultaneously releasing trace minerals from rocks and clay through the use of strong acids. Additionally, below ground mycelial networks control the movement of nutrients throughout environments, thereby influencing which plants and animals can grow in a given habitat. Nearly all wild plants are fed by fungi that associate with their roots and move nutrients between plants. The aboveground tissues of all plants are permeated by hundreds of trillions of fungal colonies that provide disease, drought and insect protection from inside.

Despite our wealth of knowledge on the importance of fungi on plant health, their positive influences on animals remains largely unknown. We know that in ruminant animals like cows, fungi are responsible for the fermentation of plant matter in the animal's rumen, creating the cud that is re-swallowed by the animal to digest in its true stomach. Likewise, yeasts in the guts of beetles—the world's largest group of insects—are essential for the digestive prowess of these insects and may influence their overall health. In humans we know that along with the bacterial microbiome of our mouths and digestive tract, there are also distinct communities of fungi—mycobiomes— that shift in population based on our diet and other environmental influences.

These internal (endosymbiotic) fungi may very well influence human health to profound degrees that have yet to be fully recognized. Even if this influence is minimal when compared to plant-fungal relationships, it is still likely to be instrumental in our digestion and human immunity. As our understanding of how the population, diversity and integrity of the human mycobiome is further refined, how might fungal supplements, or promycotics, of the future be designed to positively influence the symbiotic fungi inside our bodies?

Though our understanding of the mycobiome is only now developing, there are various ways to bring the health benefits of fungi into our lives. Along with the foods noted above, one area that has largely remained unexplored is the consumption of mushroom mycelium as its own unique, nutrient-dense food. Just as the mycelium of beneficial molds can be grown on grains, so too can the mycelium of mushrooms be grown on a wide range of products—from herbs to grains and legumes, animal tissues to mineral sources, and their innumerable combinations—to create products with a range of flavors and nutrient profiles and, more notably, an abundance of medicinal compounds found only in mushroom mycelium.

By growing mushroom mycelium on edible ingredients, food producers can design novel products with unprecedented health qualities. This high-value fungal food has largely gone unexplored due to the slow development of reliable and inexpensive mushroom mycelium cultivation practices—processing methods that are now more readily available, yet unknown to most food producers. In the field of industrial design, companies like Ecovative are biofabricating mushroom mycelium into eco-friendly, functional products from packaging to construction panels. In fashion, MycoWorks is growing a sturdy, animal-free "leather" using the mycelium of Reishi. A future of mycelially-enhanced foods is likewise within reach. As awareness around fungi increases in the coming years, demand for fungal products will need to be addressed across a range of untapped industries, setting the stage for a new era of wellness in the age of fungal food-medicines.

ORGANISM DESIGNERS

CHRISTINA AGAPAKIS & GINKGO BIOWORKS

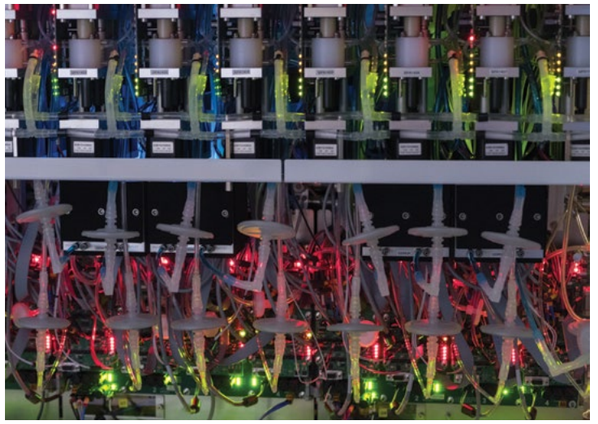
TEXT
BY JOHNNY DRAIN

MICROBES. THEY'RE EVERYWHERE:

Our skin, hair and insides teem with trillions of them. It's impossible to measure, difficult even to estimate, but it is thought that 50 to 90% of the cells in our bodies are guests, other, not 'us'. Which is weird.

With such proliferation it is little wonder that microbes have been put to work by industrious humans over the past 7,000-odd years: yeasts for brewing and baking, bacteria and molds for culturing yogurt, butter and cheese. For the past hundred years or so we've used them to make useful chemicals like citric acid and amino acids, and pharmaceuticals. The deal we've struck? We feed them and provide them with conditions favorable to their prospering. In return they multiply, producing useful compounds for us as by-products of their life cycles. Without them, life would go on — we would survive, just — but our existence would be far more pallid, within and without.

In the past people tuned microbes, modifying their genetics to produce certain characteristics, through domestication — just as we've done for eons with crops, livestock and pets. However, in the last 20 to 30 years it has become possible to do this through more tailored forms of genetic engineering: synthetic biology has enabled us to rethink manufacturing and design with DNA by using engineering principles to devise and build biological systems that can process information, manipulate chemicals, fabricate materials, produce foods and flavors, and maintain and enhance human health. Indeed, most vitamins that go into packaged foods, such as riboflavin in cereals, are now produced this way.



Under the hood of an automated fermentation system at Gingko Bioworks.

A ROSE BY ANY OTHER NAME

In part of a converted dry dock in Boston, Christina Agapakis, a genetic engineer and Creative Director for Ginkgo Bioworks, talks through some of the ways they use synthetic biology. In one project Ginkgo have been trying to design and reprogram yeasts to produce a rose-like scent. "To make a rose smell like a rose there are a lot of different molecules that the rose makes," she explains as she presents two vials: they contain the output of two yeast strains that have had their genetics modified in different ways to produce compounds that regular yeasts don't. They look like the brownish dregs of a beer. While both liquids are distinctively rose-like, one is more floral and the other more bready and sweet: they produce two different components of the rose. One day, Ginkgo hope to be able to develop a single yeast that produces both those major components and tune the yeasts to provide a custom rose blend. "That's really hard to do! But we're working on it," enthuses Agapakis.

Having designed and genetically modified a yeast and found the optimal conditions for its propagation, Ginkgo end up, if all goes to plan, with a highly bespoke solution unique to a customer's very specific question — a yeast that produces rose-scented compounds or a certain vitamin, for example. With a library of microbes, repurposed and redesigned to serve novel functions, and the understanding of biological mechanisms and pathways that they develop in creating each one, such methods could be incredibly powerful.

THE SEEDS OF GINKGO

Ginkgo was spun out of an MIT research lab in 2008 by four Ph.D.s and an MIT professor, renowned computer scientist Tom Knight. Knight had become fascinated that the next interesting thing to program and design would be biology and wanted to apply similar things he had seen in the early days of computing in the '60s and '70s — the development of tools to prototype and test, to model and predict — to help turn biology into a more design-led discipline. Since then, Ginkgo has been combining biological insights from the past 40 years with computational muscle and advanced robotics—that have become available in the past 10—to design microbes to 'brew' smells, flavors and nutritional ingredients with unprecedented precision and in more sustainable ways.

GINKGO'S DESIGN FOUNDRY

Although it may not look like one, Ginkgo is, in essence, a design firm. At the heart of all they do are three processes — designing, building, testing — but instead of working with metal, glass, concrete or plastic, their materials are biological, living

organisms. Keen to avoid controversies that can badger the acceptance of novel technologies by the public—scare stories of "grey goo" that spread when nanotechnology first entered public consciousness or uncertainty around GMO, for example—part of Christina's role is to communicate the company's work, their products, their story, and engage in how Ginkgo and the public think critically about new products. "We don't make a technology, we design a product, " explains Christina. "At the highest level you want to produce something. You want yeast that's different from just 'normal' yeast."

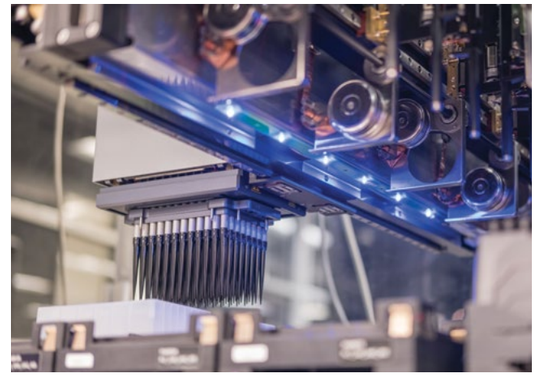
When Ginkgo's clients come to them with a question—can you make us a vitamin, a flavor, an enzyme for making a cheese, or something multi-functional that can, for example, produce flavor and aid preservation —they look first to nature. "We look at how biology solves that problem in other organisms; the enzymes, the proteins, the biochemistry, and then the genetics." Ginkgo's organism designers use computational analysis and simulations to find examples of organisms that produce, say, enzymes that might be suitable for the job, understand the pathways that produce them and the genes that code for them, and then design DNA sequences to 'insert' into yeasts to try to modify their function. "For any enzyme we're interested in there's now tons of sequences on public databases we can draw from." This is one key development of the past 10-odd years that have made this sort of work possible. Another is that the creation and replication of those DNA sequences—carried out by another company—is now much cheaper.

For each project the designers, mirroring evolution, come up with many versions: tens of thousands of DNA sequences, yeast strains and datasets to explore and test. Advancements in the automation and centralization of sample processing has driven down the cost of rapid prototyping and made organism design at this scale possible. Once the DNA has been inserted into the yeast cells, done by startling them with a chemical or electricity, the task is to identify which picked up the DNA and verify the insertion happened at the right time and place. Like evolution, there are lots of failures and dead-ends (maybe one millionth of a billion cells pick up the DNA and incorporate it into their genome). Most often when things go wrong, nothing happens. It's just normal yeast, still. Ginkgo see how the engineered strains differ from the wild, unengineered strains by cracking the yeast cells open and analyzing the chemicals therein.

Once they've found combinations of DNA and yeast strains that do what they want, they look for conditions for the yeast that will allow them to optimally extract lots of the desired final product. Ginkgo's design foundry contains fumehoods full of banks of mini-reactors and robotic arms that can monitor a wide range of fermentation variables, such as how pH or oxygen levels change as the cells grow and when the yeast needs to be fed more sugar. "We want to keep them happy because they're working hard for us. But the conditions are particular for each yeast, they all have their preferences. In the past, this would have been carried out by a human pulling out samples of each fermentation to check its progress, but now a robot can do that all night long," Agapakis explains.

BIOART & DESIGN

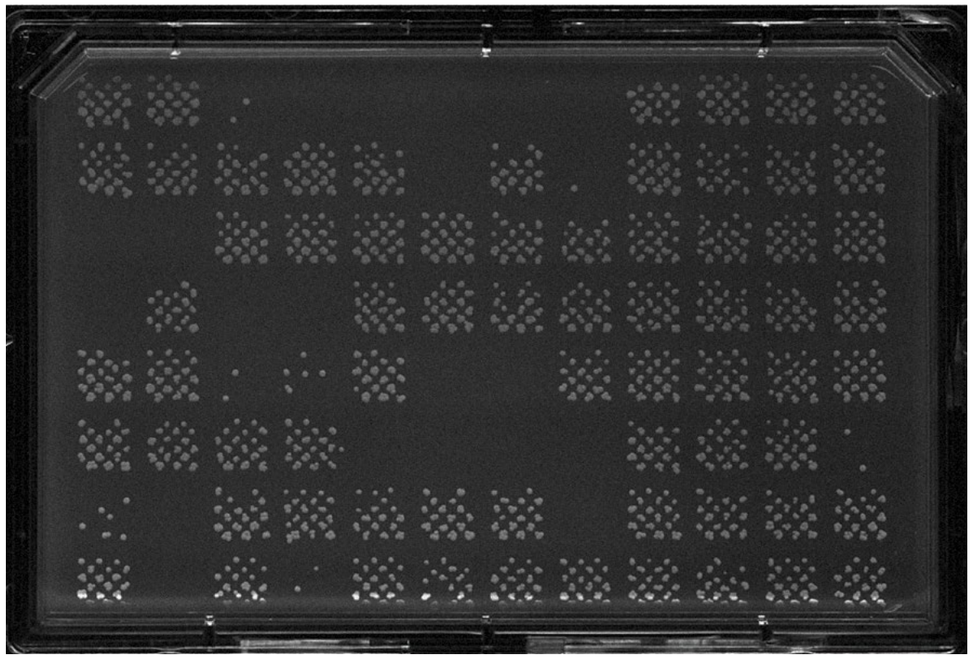
Before joining Ginkgo in 2015, Christina completed her Ph.D. at Harvard and then worked on numerous bioart projects that nurtured her interest in how artworks can help ask questions about the potential of microbes: where are they, what's their role in everyday life, what do we think of them, and how can they be a more welcome companion? The 2013 "Selfmade" project she co-created with Norwegian artist Sissel Tolaas involved a series of 'microbial sketches' that reflected the microbial landscape of different people in cheese-form: cheeses were crafted from starter cultures sampled from the belly button of food writer Michael Pollan and the tears of artist Olafur Eliasson, among other sources. The entrance to Ginkgo's offices harbors a further example that can prompt such questions: a Winogradsky panel that comprises two sheets of glass between which soil and silt is thickly sandwiched. With the passage of time, microbes in the substrate grow producing dynamic, evolving patterns that recall Monet's water lilies: subtly graduated patchworks of colors that, although abstract, suggest underlying order. When one digs further into what Ginkgo does, it becomes clear how Agapakis' interests have led her here.



LEFT At the opening of the new Bioworks2 Foundry, the research studio Extrapolation Factory setup a pop-up bio-product assembly line and invited designers to envision possible biotech futures through conceptual objects.
RIGHT Close-up of a liquid handling robot used at Ginkgo Bioworks to engineer microorganisms.

FUTURE FOODS?

"It's about how can we use microbes to improve flavors or enhance character. The technology will help us to better understand and work with bacteria and



Yeast colonies arrayed on agar.

yeasts to make good food in the future," Christina reflects. What remains to be seen is how the public will respond to such foods: although 'brewed' products, like the rose scents, are likely to avoid GMO-certification because the genetically-modified parts of their manufacture — the yeast cells — are removed, numerous ethical questions remain. Concerns about whether the technology is intrinsically problematic revolve around whether something is violated when biological systems, whole organisms even, that aren't found in nature are created to fulfill roles defined by humans: does life, if it is considered to have it in the first place, lose its sacredness if it is designed? If we are dealing with microbes producing flavors or vitamins then many would consider not, but what happens when synthetic biology involves organisms closer on the phylogenetic tree to human life?

Moreover, there are the extrinsic considerations; the potential risks and benefits. Aside from the danger of deliberate misuse of the technology to create pathogens or toxins that can be weaponized, there is the possibility of organisms inadvertently escaping, and evolving and adapting to new environments in ways unforeseen by their creators. One lesson that the study of traditional biology teaches us is that living things and their interactions are complex, often more so than we initially perceive. We must be mindful of not being over-confident that we can control and predict the behavior of artificially created organisms, and understand their risks. Furthermore, with synthetic biology set to offer hugely powerful ways of producing food, fuel and medicines, thinking about who controls and owns it, and ensuring they do so in line with its potentially wide-reaching social and environmental impact, is vital. Regulation, thus far, has been light, largely because many of these issues have been considered in debates surrounding existing genetic engineering technologies, but as more products are made in this way—hacking microbes in ways unfamiliar to most — it seems clear that the roles of people like Agapakis will become more critical in promoting discussions in the public domain about how such technologies work, and why and when they should or shouldn't be used.

Understandably, she is keen to focus on the expansive beneficial potential of Ginkgo's work in producing functionalized, customized probiotics and tastier food. "Maybe we make new starter cultures for cheeses; there are so many enzymes involved in ripening cheese, breaking down the oils and making all the flavors: people intuitively manipulated them without knowing that bacteria existed, so what new tastes are possible now that we understand the biology, chemistry and role of human interaction?" Moreover, could we engineer the tastes of things we don't have any more, such as rebreeding the taste back into chicken? Now that seems like a prospect that could get the public talking about synthetic biology, and that many would be willing to get behind.

MICROBIOTOURS, TEXT BY: THE CENTER FOR GENOMIC GASTRONOMY

What kind of microbial future do you desire?
Abderdeen, Scotland 2036

Microbiotours is a walking tour of the Rowett Institute of Nutrition and Health campus, created to explore invisible ecologies and bacterial subcultures. Each stop on the tour highlights the ways in which microbiome research has reshaped our daily lives and habits over the last two decades.

Debates over the relationship between human health, food, science and culture have made microbiota research one of the most vibrant and contested areas in the life sciences. We now know that each human body carries more microbial cells than human cells, and that this microbial life is important to many bodily functions. There is still a lot to learn about these tiny ecosystems, but one thing is for sure: we need them and they need us. Microbial interactions are notoriously complex and there are great pressures on researchers to create profitable products and therapies. Over the last 20 years, this has led to cycles of hype, skepticism and self-experimentation.

From Paleo Gut Gardening to the Microbiome Pick-n-Mix, this tour covers the cultural history of the microbiome era as well as emerging products, practices and research.

STOP 1: THE SHITBIT

This commemorative restroom contains the first personalized microbiome sequencing technology. Created by a research team in 2019, the device was designed to give a readout of the unique microbial composition of a user's gut. In the original prototype displayed here, human feces passed through the donut, where a sample was taken by the small needle. The results were then transmitted directly to the user's phone or device. The ShitBit now sequences and analyzes fecal samples from hundreds of thousands of individuals worldwide.

STOP 2: MICROBIOME PICK-N-MIX

This is a proprietary probiotic station designed for luxury office kitchenettes. The Institute is still completing human subject trials, but soon ShitBitPlus™ subscribers may be able to use their stool sample readings to customize their Pick-n-Mix topping. Imagine snacking on a unique combination of microencapsulated probiotics, selected based on your body's needs. Sprinkle them on some frozen yogurt, and head back to your desk feeling re-populated and refreshed!

STOP 3. THE DUMP TRUCK

This parking space is reserved for a "food" truck that offers cosmetic fecal transplantation. Reseeding your microbiome with another's feces is no longer just a medical option. At the Dump Truck, choose from a menu of fecal transplants including authentic celebrity samples, foreign travel readiness, or beauty treatments for your insides. With the option to "s(h)it in or takeaway," you can either perform the procedure in one of the Dump Truck's Changing Stations or take your sample home in an odor-free doggy bag.

STOP 4. CAMPUS CAFE

This campus cafeteria serves as a living laboratory for microbiome materials research. It contains 3D-printed plants seeded with communities of micro-organisms designed to regulate the room's ambient environment. The overuse of antimicrobial surfaces in architecture—particularly in public spaces like this one—throughout the 2020's necessitated the development of more holistic approaches to inter-species design in the built environment.

STOP 5. MICROORGANISM DISPOSAL UNITS

This is where the institute stores its B-Waste, the leftover, unwanted outflows of microbiome research. As it began scaling its microbiome research in the 2020's, the institute saw a need to establish a comprehensive B-Waste initiative. Back then it was common to radiate unwanted biological material, destroying everything, instead of recycling or composting it. As it turns out, this living material can be recaptured and used to generate chemicals or other useful byproducts.

STOP 6. FIELD AND SKY

Here, we invite you to lay down on the grass, look up at the sky, and listen to this historic quote, "If microbiome science tells us anything, it's that everything is secretly ecology. The biology of oceans and bodies and soils is really about the connections and relationships between living things, many of which have gone unnoticed for too long. It will take new human relationships to understand them." (Ed Yong, science writer, 2016)

STOP 7. PALEO GUT GARDENING

We have arrived at the Paleo Gut Gardening pitch. Many of our graduate students are members of this fitness group, though it has no affiliation with the Institute. Twice a week, they move this pile of rocks from one side of the field to the other. This workout combines physical exercise with an exchange of microbes amongst participants and “wild” bacteria the environment.

STOP 8. FOREST BATHING

Finally, this forest grove is part of the ongoing wellness campaign at the Institute. Twice a day, employees come outside to “take a bath” in a specially planted forest, relaxing in a composed ambient microbiome. Researchers at this site are practicing science in a new way: working across scales, synthesizing disciplines and embedding their designs in the landscape. In early analysis, happiness and morale have increased in test subjects.

A special thank you to Dr Wendy Russell, the Rowett Institute of Nutrition and Health, and the Leverhulme Trust for making this artwork possible.

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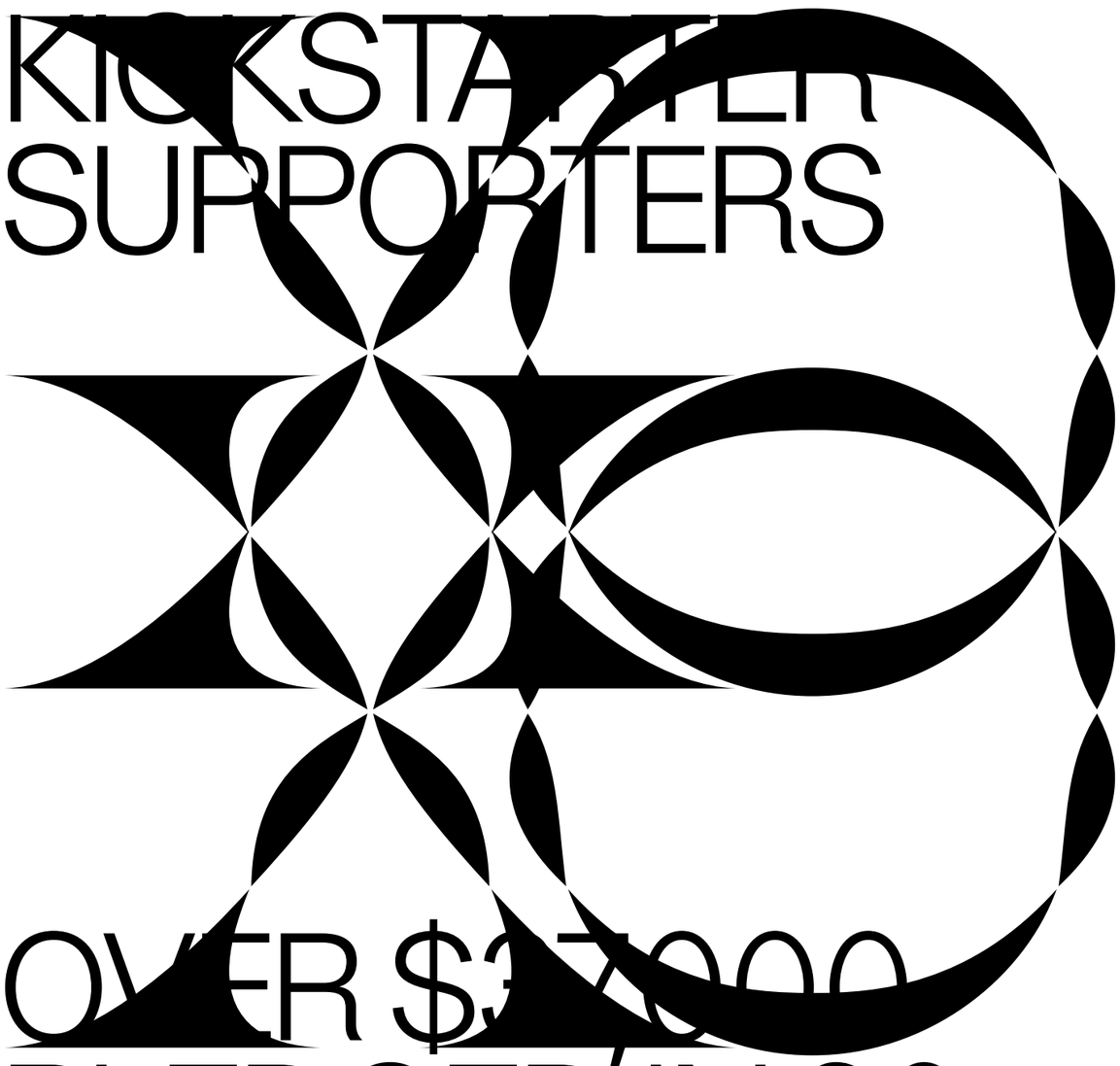

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Over 700 people contributed $37,159 towards the inaugural print issue of MOLD Magazine. The resulting funding will be used towards the production of the first three issues.

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Summer 2017

Butter, Poop, Natural Wine, Bacteria, Yeast, Toilets, Amino acids, Dirt, etc

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